THE AEROPLANE and ASTRONAUTICS

AUGUST 12, 1960

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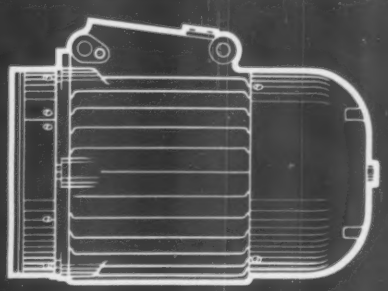
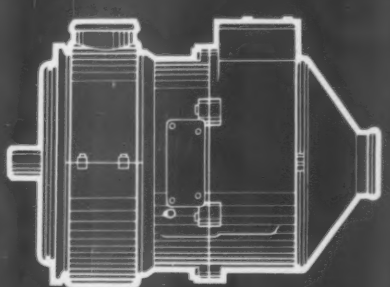
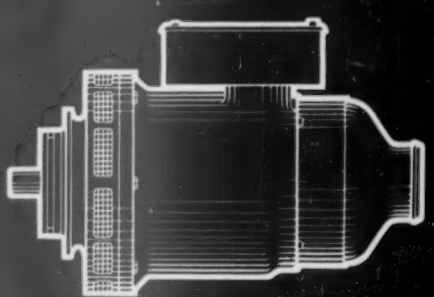


Emergency power for the Vickers VC. 10



55. K.V.A. machine for main generating systems



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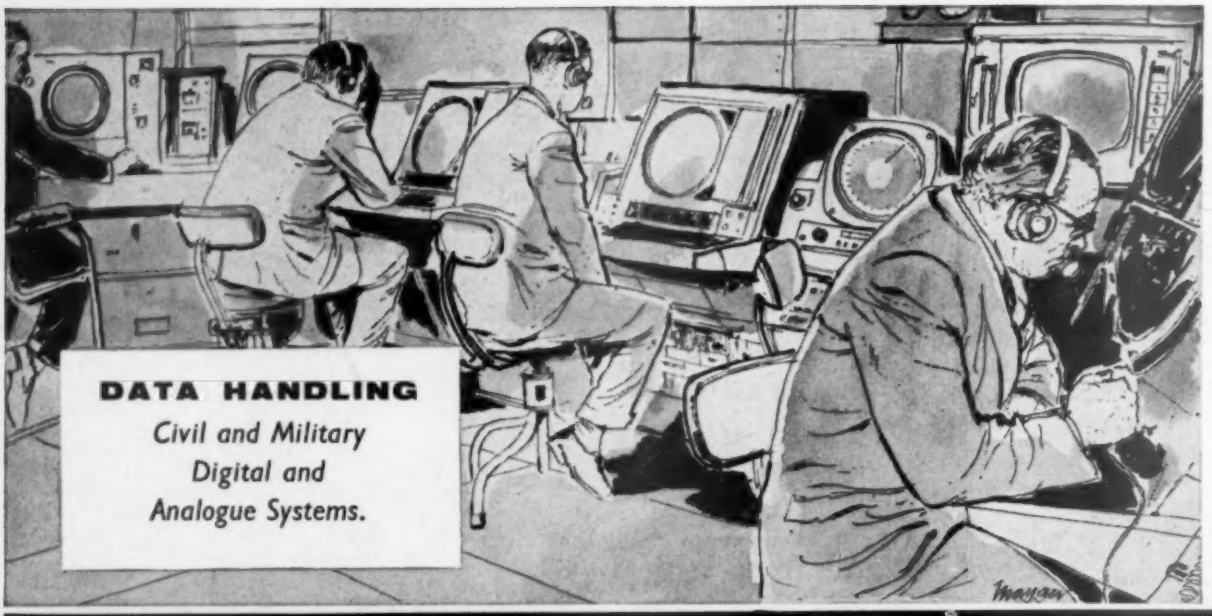

MARCONI'S cover the

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The Marconi SNW 51 is designed to present accurate pictures of storms and rain producing clouds over ranges up to 200 n. miles. It meets the needs of Meteorological Departments and Civil Aviation Authorities, particularly where data gathering from distant recording posts is uneconomic or hampered by inaccessibility. It is used by the British Ministry of Aviation and in Australia, Southern Rhodesia, British East Africa and China. Its main features include: (i) Full off centring on displays; (ii) controlled camera recording facility; (iii) remotely controlled tiltable aerial; (iv) Iso-echo presentation.

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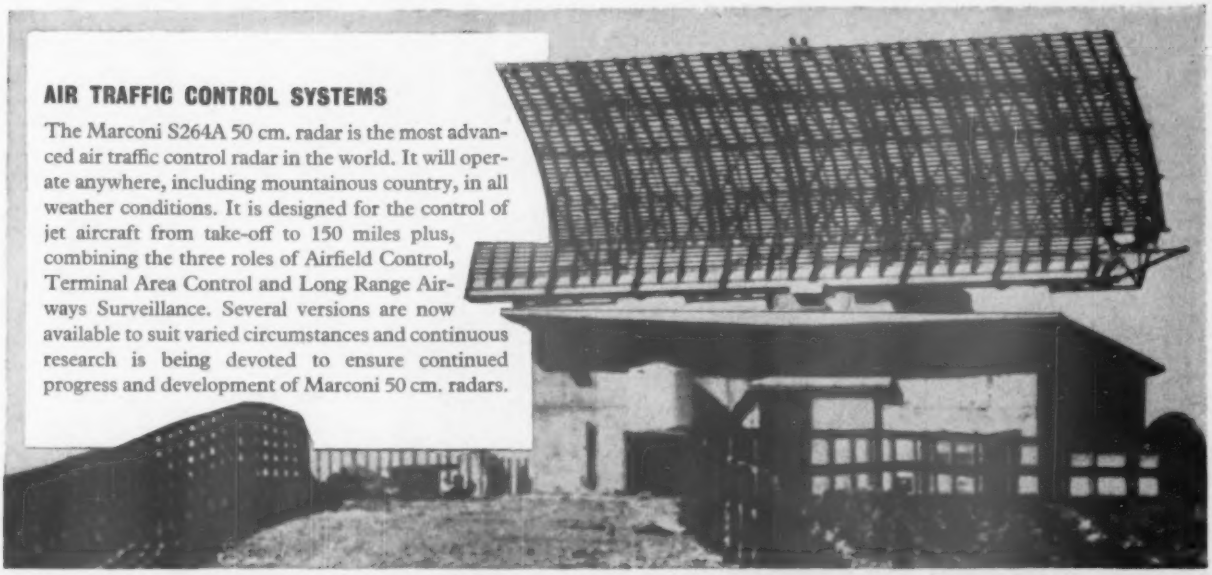

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Marconi's offer a complete consultancy and engineering service in the installation of radar systems. All Marconi radars and data handling equipment have been designed for integration into the most advanced air traffic control and defence systems at present in operation or contemplated in the forseeable future. Marconi radar is in constant use in 36 countries.

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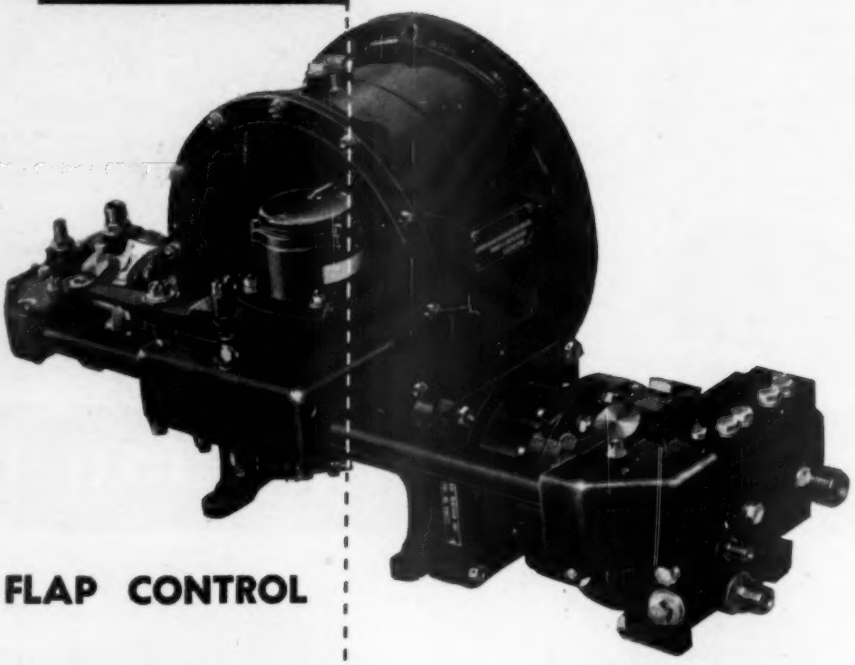

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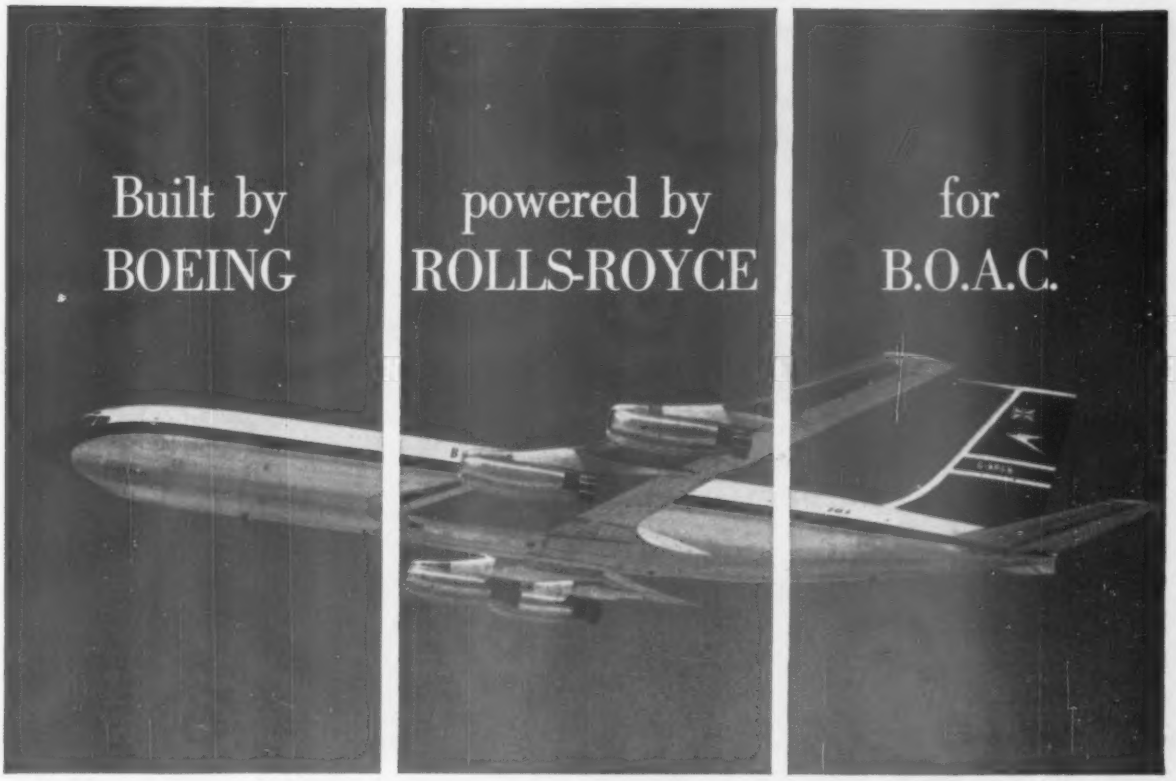

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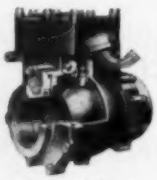

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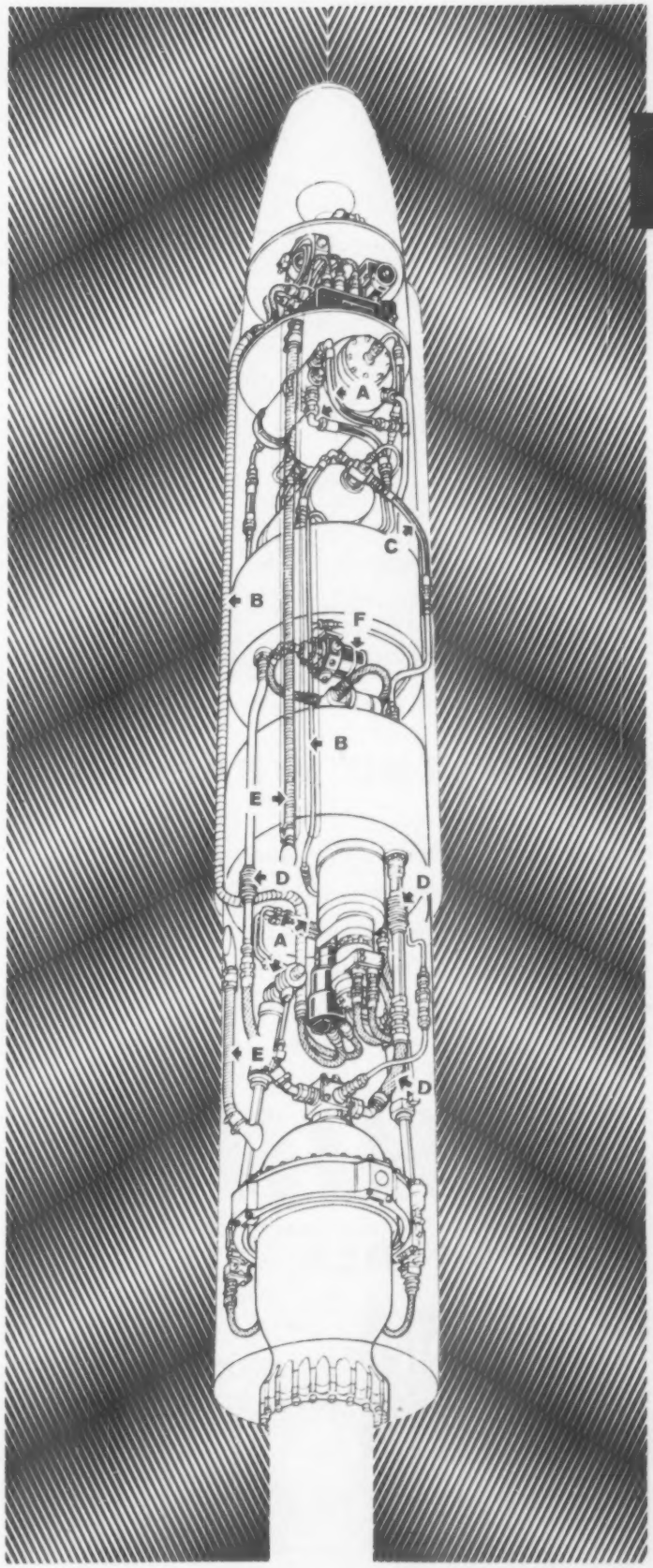

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AVICA high performance components for piping and ducting systems find many applications throughout all British Guided Missiles, and their Support Equipment. This hypothetical rocket shows a representative cross section of the Avica range as applied to rocketry.

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THE AEROPLANE and ASTRONAUTICS

VOLUME 99 NUMBER 2547 AUGUST 12, 1960

The Art of Estimating

Recently published, the Second Report from the Committee of Public Accounts, Session 1959-60 (Cmd. 256) has made what has been described as a scathing criticism of financial control by the now defunct Ministry of Supply and its successor, the Ministry of Aviation. The White Paper does not limit its comments to this particular subject; a number of other affairs are examined but the matters we propose to discuss occupy some two dozen pages of the Report. They are summarized on p. 176 of our present issue.

In its report the committee states that the results show the need for the principles it laid down earlier to be followed. These were that original estimates should be fully and carefully examined by the Ministry's technical and finance staff; that the Treasury be warned specifically if the cost estimate were conjectural and might well prove too low; that a careful and continuous watch be kept on the progress of work in relation to the expenditure on it; and that regular and frequent reviews of cost should be made by the Ministry, with any increases promptly reported to the Treasury.

Primary responsibility for initial estimates is to be placed on the technical staff, instead of on the finance staff as in the past; the finance staff is to be responsible for criticizing the estimates and for approving them after all parties concerned, inside or outside the Ministry, have been fully consulted. It will be the responsibility of the technical staff to see that the work is executed within a prescribed budget based on estimates of cost and time required, and to ensure that any variations due to technical developments are properly examined and justified at the earliest possible change.

All of which is unexceptional.

* * *

Price estimation is well known to be a difficult field in which to achieve close accuracy. Where such accuracy is achieved it will generally be found to result from continuous and continuing cross-checking of estimate with expenditure and adjusting the factors used in estimating. Such a procedure, though tedious, is practical with standard and well-understood processes. When one is faced with developing something as complex and unknown in its behaviour as a new venture in guided missiles the problem must become nearly overwhelming.

A cognate problem arose in the early days of planning airframe programmes at the Ministry of Aircraft Production. Insufficient attention had been given in the past to the collection and analysis of production times. In this instance further difficulties arose from the lack of liaison between the technical and financial branches on such matters.

It seems, however, that some part of this lesson has now been absorbed, for primary responsibility for initial estimates is to be placed on the technical staff instead of on the financial staff, as in the past. This seems a sound step in that the technical staffs should be much more familiar with the type of problems likely to be encountered. But the complexity of the problem will in nowise be reduced thereby.

It needs to be realized that not only is it always later than one thinks, but also the path of research and development is always more difficult than one thinks. It is likely that meticulous examination will show that excess of expenditure over estimate basically arises in most instances from the occurrence of the unforeseeable contingency.

Editor - - - - - THURSTAN JAMES
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Matters of Moment

Reducing the Victor Orders

ANNOUNCEMENT last week (Aug. 2) of the Government's decision to cancel an unspecified number of Victor B Mk. 2 aircraft set off a great deal of argument and counter-argument. The debate has yet to be concluded, though the R.A.F. have been at pains, both officially and unofficially, to let it be known that they are quite satisfied with the decision. The officially disclosed reasoning is such, however, to encourage the belief, widely held, that the cancellation is not so much for the technical reasons disclosed as for others. Chief among these is the suggestion that a present economy will ensure the future of the T.S.R.2, now being designed by B.A.C. As is customary, though no official specifications have been released, characteristics and capabilities of the new design seem to be widely known. It is credited with the ability to carry nuclear weapons, to be supersonic at low and high levels, and to have STOL capability.

Another reason advanced is that if economy is necessary, it is better that cuts should fall on an independent firm than on one of the group firms which have been assured of Government support.

There will be many people who will agree with the point of view expressed by one eminent engineer who, on reading of the estimated £80 million loss to the nation on the cancellation, said it seemed to be an awful lot of money to pay for not having that number more Victors. Estimates of the number of aircraft cancelled have ranged from 12 to 30.

It will not escape the more observant that these apparently firm decisions are based on the operational capacity of a weapon which has yet to be produced and of which the prototype has not been tested. Even in wartime decision and counter-decision raged as new developments or the lack of them rendered previous conclusions nugatory. Blue Streak has been cancelled. Trials of Blue Steel, the British limited range stand-off bomb, are in hand. Skybolt has yet to appear. It is difficult to believe that absolutely final decisions about the size of the V-bomber force can be safely reached yet.

Sir Frederick Handley Page who appeared on TV to answer questions about the cancellation has said that it represents only a small proportion of the total order. He has also said that the Victor can carry two Skybolts without modification to the wing structure. He has pointed out that the Victor has flown with the equivalent of a Skybolt under each wing. He was referring to the fuel pods which represent the equivalent of the Skybolt in weight and drag. It is for this reason that the demonstrated ability of the Victor to land with only one fuel tank in position is significant.

The R.A.F. has justified its decision on the lines that design studies now show that two or more nuclear-headed Skybolts can be carried by each V-bomber. As each Skybolt can be air launched individually against a specific target, the same number of targets can be engaged by half the number of bombers.

It remains to be pointed out that our photograph shows the Victor Mk. 1 carrying the fuel pods. The Victor Mk. 2 with Rolls-Royce Conway turbines has not yet entered squadron service and presumably will not do so until the findings into the causes of the crash of the prototype last year have been accepted. It was recently announced that more than half the crashed aircraft had been recovered from the sea by the Royal Navy.

Astronautics in Stockholm

NEXT week in Stockholm, the 11th Congress of the International Astronautical Federation opens under the auspices of the Svenska Interplanetariska Sällskapet (Swedish Interplanetary Society). It opens on Aug. 15 and finishes on Aug. 20. More than 500 of the World's leading scientists and engineers engaged in aerospace research and development will be present, including well-known authorities from the United States and Russia. The Soviet delegation will be led by Prof. L. I. Sedov who was elected president of the Federation at last year's Congress in London.

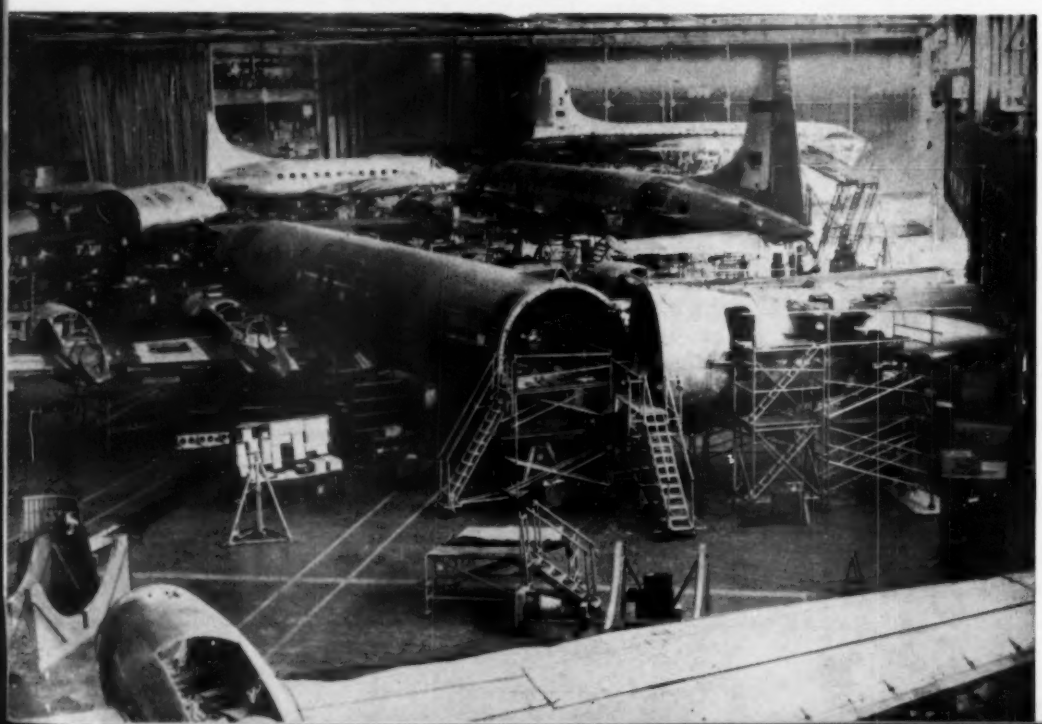
Comprising about 30 rocket and spaceflight societies in almost as many countries, the I.A.F. has approximately 20,000 individual members from both sides of the "Iron Curtain." It differs from the other international space-research group, COSPAR, in being concerned primarily with the *technology* of astronautics, as distinct from upper-air and space physics.

Gt. Britain is represented in the I.A.F. by the British Interplanetary Society (founded 1933), which played a leading rôle in the formation of the I.A.F. in 1950-51 in company with the German and French societies. Our delegates to the Stockholm Congress will be Dr. L. R. Shepherd (B.I.S. President), Mr. G. V. E. Thompson, and Mr. M. N. Golovine.

There are two groups from the United States, the American Rocket Society, founded in 1930, and the American Astronautical Society, founded in 1954. Russia is represented by the Commission on Interplanetary Communication, organized by—and part of—the U.S.S.R. Academy of Sciences. This group manages the basic research, design and launching of the Soviet Sputniks and Luniks; the 27-man committee is headed by Prof. Sedov himself.

As is customary with the annual Congresses, the programme is divided into two main parts: business sessions of the member-societies, and a programme of international lectures. High on the agenda of the business sessions will be formal approval of two new organizations, sponsored by the I.A.F. These are the Academy of Astronautics, for which a grant of $75,000 has been received from the Guggenheim Foundation (THE AEROPLANE AND ASTRONAUTICS, Jly. 8, 1960, p. 51), and the Institute of Space Law.

A record number of lectures—the majority American—has been accommodated in the main lecture programme, which covers an extremely wide field of astronautical interest. In addition, four specialist meetings have been arranged, a Space-Medical Symposium, a Small Sounding Rocket Symposium, an Astrodynamics Symposium, and a Space-Law Colloquium. The last mentioned has been organized by Mr. Andrew G. Haley, the authority on international law and former president of the I.A.F. The Colloquium will consider: (1) International Control



SWING-TAIL FREIGHTER.—Scheduled for roll-out this month and delivery early next year, the first commercial model of the Canadair CL-44 with a swing-tail is seen in final assembly here. Orders have been placed by Flying Tiger, Seaboard and Western, also Slick.

UNDERWING CAPABILITY.—In flying with slipper fuel tanks the Handley Page Victor Mk. 1 has shown its ability to carry heavy loads suspended from its wing. According to Handley Page, each tank is equivalent to one Skybolt as regards weight and drag.

of Outer Space; and (2) Damages to Third Parties on the Surface Caused by Space-Vehicles.

Full reports of the Stockholm Congress will appear in appropriate issues of this magazine.

New Scientific Adviser

DIRECTOR of the National Gas Turbine Establishment at Pyestock, Mr. Hayne Constant, C.B., C.B.E., M.A., F.R.Ae.S., M.I.Mech.E., F.R.S., has been appointed Scientific Adviser to the Air Ministry with effect from Sept. 1. He succeeds Mr. M. B. Morgan who, as reported in our issue of Jly. 8, will return to the Ministry of Aviation as Deputy Controller of Aircraft (Research and Development).

Mr. Constant, who is 55, has devoted most of his career to engine development. Educated at Queens' College, Cambridge, he joined the R.A.E. as a scientific officer in 1929. Between 1934 and 1936 he was post-graduate lecturer in internal combustion engines at Imperial College, after which he returned to the R.A.E., becoming head of the engine department in 1941. Between 1944 and 1946 he headed the research department of Power Jets (R. and D.), Ltd., and was its deputy director (research) from 1946 to 1948, when he was appointed director of the N.G.T.E. During his eleven years at Pyestock the facilities of the establishment and its field of work have been greatly expanded.

The X-15 Programme Continues

AFTER a two-month gap in the flight development programme, one of the North American X-15s made, on Aug. 4, the fastest recorded manned-aircraft flight. It is reported to have reached a speed of 2,196 m.p.h. (M=3.3) towards the end of its 4 min. 15 sec. rocket-powered climb to 78,000 ft. after being dropped from its B-52A parent aircraft at 45,000 ft. The pilot was Mr. J. A. Walker, of the National Aeronautics and Space Administration.

This X-15 was aircraft No. 1, which had been accepted by the U.S.A.F. and turned over to NASA. The first two X-15s have been flying with Reaction Motors XLR-11s (16,000-lb. total thrust); the third was fitted early in June with the 57,000-lb. XLR-99, but an explosion during ground tests destroyed much of the airframe and it is believed to be a write-off. The XLR-99 motor is due to be fitted retrospectively to X-15 Nos. 1 and 2.

These aircraft have made between them about 30 flights, 14 of them "captive" (i.e., remaining with the mother aircraft), either deliberately or otherwise. No. 1 made its initial flight with NASA on Mar. 25 this year. No. 2, which, at least until recently, had been continuing its manufacturer's programme, was damaged when landing on Nov. 5, 1959, after an explosion while airborne, but was on test again by Feb. 4, 1960.

Mach 2 Engine Data

PERFORMANCE details of the General Electric J79 have been officially released in the U.S. for the first time. This engine has accounted for the bulk of the American flight experience at speeds above Mach 2, since it powers the Lockheed F-104 Starfighter, Convair B-58 Hustler, McDonnell F4H-1 Phantom II and North American A3J-1 Vigilante.

All four aircraft types are currently in production, for the U.S.A.F. and U.S.N., and the Starfighter is also on the point of going into production in Canada, Germany, Japan, Belgium and the Netherlands. To provide engines for these foreign F-104 production lines, the J79 is to be built by Orenda Engines in Canada, by B.M.W. in Germany and by Ishikawajima in Japan.

The released data relate to four models of the J79, but details of another advanced version for the production models of the F4H-1 and A3J-1 remain restricted. The J79-3A powers the F-104A and B models of the Starfighter, now out of production, and the J79-7 powers the current F-104C and D. The J79-5B is used in the production B-58A and the J79-2 is the first version for the U.S. Navy, powering prototypes of the F4H and A3J. All models are provided with afterburners, the take-off thrust quoted in the table above being with afterburner operating. All thrust figures are static at sea level.

	J79-3A	J79-7	J79-5B	J79-2
Take-off thrust, lb.	14,800	15,800	15,600	16,150
S.F.C., lb/hr./lb.	2.04	1.97	2.08	1.93
R.P.M.	7,460	7,460	7,460	7,460
Military thrust, lb.	9,600	10,000	10,000	10,350
S.F.C., lb./hr./lb.	0.87	0.84	0.84	0.84
R.P.M.	7,460	7,460	7,460	7,460
Normal thrust, lb.	8,950	9,700	9,700	9,700
S.F.C., lb./hr./lb.	0.865	0.83	0.83	0.83
R.P.M.	7,460	7,460	7,460	7,460
90% normal thrust, lb.	8,050	8,740	8,740	8,740
S.F.C., lb./hr./lb.	0.834	0.797	0.797	0.797
R.P.M.	7,300 ±1%	7,300	7,170 ±1%	7,300
75% normal thrust, lb.	6,710	7,270	7,270	7,270
S.F.C., lb./hr./lb.	0.825	0.78	0.78	0.78
R.P.M.	6,960 ±1%	6,950	6,900 ±1%	6,950
Engine length, in.	207.45	207.96	202.17	207.96
Engine diameter:				
Compressor, in.	30.34	30.34	31.63	30.34
Nozzle, in.	38.31	38.31	38.0	38.31
Engine weight, lb.	3,255	3,375	3,635	3,620
Compressor inlet area, sq. in.	652	652	654	650

Matters of Moment . . . .

A VTOL Transport to be Built

IN order to help all three U.S. Services to define in detail the engineering and field requirements for VTOL aircraft, a large VTOL transport test-bed is to be built in America. Its testing will precede the detailed design of any operational VTOL types to be ordered in quantity. A committee representing the three Services and other interested parties is at present considering the form to be taken by this project, which will be paid for out of funds for the fiscal year 1961. The order will be placed, it is expected, before the end of the year.

Experience has already been obtained in the U.S. of a wide variety of VTOL configurations by means of full-scale prototypes ranging in size up to the 30,000-lb. Hiller X-18 tilt-wing. One of the earliest of this series of research aircraft, the McDonnell XV-1, featured the off-loaded rotor principle which has subsequently been more fully exploited in the Fairey Rotodyne, and although no other aircraft of this type were built in the U.S., the success of the XV-1 itself has caused this type of aircraft to be favoured recently. Sikorsky Aircraft has also been conducting wind-tunnel and full-scale flight trials in the use of wings to off-load helicopter rotors as part of a general investigation in this field (a Sikorsky project in the same class as the Rotodyne was illustrated in our issue for Jan. 29, 1960).

It would be ironic indeed if the U.S. were to proceed with a VTOL transport of the unloaded rotor type at the very moment when the future of the Rotodyne is once again under review. Persistent rumours have been circulating that the Westland company believes the cost of developing the Rotodyne into a satisfactory civil transport to be too great for the programme to be pursued on the basis of the £4½-million Government development contract. Reduction in the noise of the tip pressure jets is one of the major problems.

Rotorcraft Records

THREE Russian-held world helicopter records and four other international rotary-wing marks have been beaten by a Bell HU-1 Iroquois helicopter of the U.S. Army. During the eight days ended Jly. 26, flights were made in the speed, distance and climb categories by Col. Jack Marinelli, president of the Army Aviation Board, Maj. G. J. Boyle and Chief W.O. C. V. Turvey.

The new records comprised a time to climb 3,000 m. (9,843 ft.) of 3 min. 22.4 sec.; to 6,000 m. (19,686 ft.) in 8 min. 10.2 sec.; a closed-circuit distance of 441.74 miles; a 3 km. (1.864 miles) speed run at 158.05 m.p.h.; a 500 km. (310.7 miles) speed run at 148.45 m.p.h.; and a 100 km. (62.14 miles) speed run at 142.2 m.p.h.

The closed-circuit distance and 100 and 500 km. speed records were previously held by the Russian Mi-1 helicopter, while the 500 km. figure also exceeded the maximum speed, of 136.02 m.p.h., in all weight categories, established by a U.S. Army Sikorsky H-34. The previous best times to height had been set up by the French Alouette.

Sprites for Development

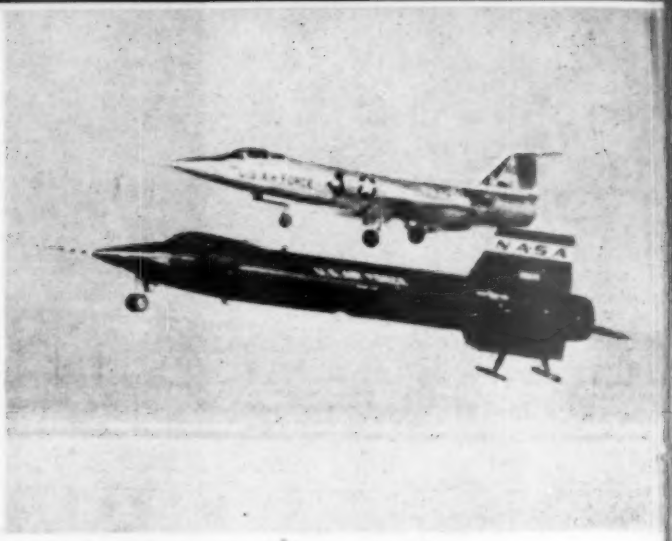
WESTLAND AIRCRAFT has received an order for a pre-production batch of Sprite helicopters for the Army Air Corps. The first of this batch, powered by a 650 s.h.p. Blackburn Nimbus (derated from 885 s.h.p.) flew on Aug. 4. In Army colours and bearing the serial number XP167, it is strain-gauged for performance and handling trials.

The Army Sprite is identified as the Saro P.531-2 Mk.1, and has a slightly longer fuselage than hitherto, giving six inches more space in the rear compartment. The Sprite is intended for a variety of duties including liaison, light freighting, casualty evacuation, air-sea rescue, reconnaissance, training and weapons launching. A lightweight Lucas air-operated hoist can be fitted.

Checks on Development Costs

SCATHING criticism of financial control by the Ministry of Supply over aircraft and missile contracts is a feature of the Second Report from the Committee of Public Accounts, published recently. It may well lead to a further tightening of financial control over contracts.

Details are given of three missiles whose development costs were respectively some 30, 10 and six times as great as originally estimated. Although not mentioned by name in the report, it is not difficult to identify them as Seaslug, Thunderbird and Firestreak. The estimate for Seaslug development was £1-1½ million; it is now expected to be £40 million, plus £30 million for the shipborne radar developed for the Admiralty. The missile will also enter service some five years later than originally planned.



MACH 3.3.—X-15 No. 1 comes in to land at Edwards A.F.B. after the four-minute powered run on which (see p. 175) it reached a speed equivalent to about M = 3.3. Behind is one of three F-104 chase aircraft which flew with the X-15.

Total cost of Thunderbird development was estimated at £25 million in 1950. The latest estimate for the direct cost of developing the original version of the weapon is £27 million; this version is in limited production for the Army. The estimated total cost of developing and testing the complete weapon system and associated radar equipment is £40 million.

The third missile discussed is Firestreak; in 1952 its total development cost was estimated to be about £4 million. The latest estimate for the Mk. 1 missile is £23 million; if associated equipment is included, the estimate is £33 million. The direct cost of developing the Mk. 4 missile is £20 million.

The Committee also criticized the cost of navigation aid trials—apparently of Dectra—made by Boscombe Down aircraft. It was estimated that they would take 150 flying hours at a cost of £40,000. In fact, 615 hours were flown at a cost of more than £300,000. The Ministry explanation was that expenditure in their research and development establishments was not controlled and accounted for project by project; only expenditure for the establishment as a whole was controlled. The Ministry is now trying to set up a cost accounting system at all their R. and D. establishments, but this will not be fully effective for another two years.

Thruxton Races

AMONG the air races to be held at Thruxton during the Wiltshire School of Flying "At Home" on Sunday, Aug. 21, is the first-ever Ladies' Handicap event in this country.

There will also be one-class "round the airfield" races for Turbulents, Tiger Moths and Jackaroos, each for six aircraft, and an open handicap event over a 58-mile course for all types and any number of aircraft. The organization is being kept fairly informal, but competitors should arrive at Thruxton by dusk on Saturday, Aug. 20. Visitors arriving by air must land before 13.00 hrs. on Aug. 21; the programme starts at 14.00 hrs.

John Henry Davis

NEWS of the sudden death of Jack Davis, at the age of 62, in London last week (Aug. 3) will come as a shock to people in many different parts of the world, for the much-travelled European representative of Canadair, Ltd., was widely known and highly regarded. A pilot in the R.F.C. in World War I, John Henry Davis, on demobilization, joined a firm of accountants in Paris where he first acquired his knowledge of French and German. His great flair for languages was later to prove invaluable. In those early days he was a near neighbour of W. S. Shackleton, then a designer with Blèriot at St. Cloud. At one time Mr. Davis ran a soap factory at Istanbul.

Later he moved to Vienna, where he directed a valuable printing business until the German occupation of Austria. A keen private aviator, he owned a Hirtenberg monoplane and in this he flew to England in the fateful summer of 1939.

In the early stages of World War II Mr. Davis became works manager of Bristol's Roadney Division and later overseas sales manager. One result of his linguistic ability was the giving of German language broadcasts during hostilities.

In April, 1949 he became European representative of Canadair, Ltd., and as such was responsible for the very substantial sales of Sabre aircraft made in his territories.

A grand character, he will be much missed, not only for his business acumen but for his personal qualities.

BS.53—Swivel-thrust Turbine

Powerplant for Hawker P.1127 VTOL Fighter

PHOTOGRAPHS and new information about the BS.53 lift-thrust engine have been released by Bristol Siddeley. Known until recently as the BE.53, this ducted-fan engine has been chosen to power the Hawker P.1127, whose first flight is expected soon. This VTOL aircraft is unique; it is no research type but the first VTOL fighter in the World to be designed for operational service.

High take-off thrust and a low s.f.c. are features of the BS.53. A front-fan engine, it has bifurcated jet exhausts from both the front fan and turbine jet-pipe. Cascade-bladed nozzles on these exhausts can be revolved so that the engine thrust is directed downwards to give vertical lift, horizontally backwards to give propulsive thrust or at any angle between to give a combination of lift and thrust. Nozzles can also be directed slightly forward of the vertical to give braking thrust during the approach to a vertical landing.

Few details of BS.53 internal layout have been given except that it is a two-spool engine with the ducted fan and high-pressure compressor revolving in opposite directions so that there is little resultant gyroscopic couple. According to Bristol Siddeley, "the high-pressure compressor, its turbine and flame tubes are based on well-known principles already proved in service:" this suggests that they may be derived from an existing Bristol Siddeley engine, possibly the Orpheus.

The diagram on page 179 probably gives a close approximation to the internal layout of the engine; it appeared in a lecture given late last year by Dr. S. G. Hooker, the company's technical director (aero).

At the S.B.A.C. Show last year Bristol Siddeley exhibited a civil turbofan engine, the BE.58. Examination suggests that this engine is closely related to the BS.53, although it does not have the bifurcated front-fan and jet exhaust of the military lift-thrust engine. Performance of the BE.58 was given as 14,500 lb. take-off thrust at an s.f.c. of 0.572 lb./lb./hr.; cruise consumption at 600 m.p.h. and 36,000 ft., 0.8 lb./lb./hr.; weight, 2,600 lb.; thrust-to-weight ratio, 5.58 : 1; by-pass ratio, greater than 1.5 : 1. Many components of this engine are derived from those of the Olympus and Orpheus.

Design of the BS.53 was begun as a Bristol Siddeley private venture, but it soon attracted interest from the Mutual Weapons Development Programme, under which it is now receiving substantial financial support. The engine has been designed primarily for light ground-attack fighters with VTOL and STOL capability. It is stated to be suitable for both subsonic and supersonic flight.

The complete engine ran for the first time in August last year. Successful tests have included the reliable operation of the nozzles. A single nozzle is being endurance tested on the jet-pipe of an Orpheus.

Design and operation of the nozzles are vital features of the BS.53 though only limited information is available. It is obvious that all four must be linked mechanically so that they move together; any independent movement might be catastrophic for a hovering aircraft. Also the control system must doubtless be designed so that the nozzles can be lowered very rapidly to the lift position, but revolved only slowly from this to the thrust position, for obvious safety reasons.

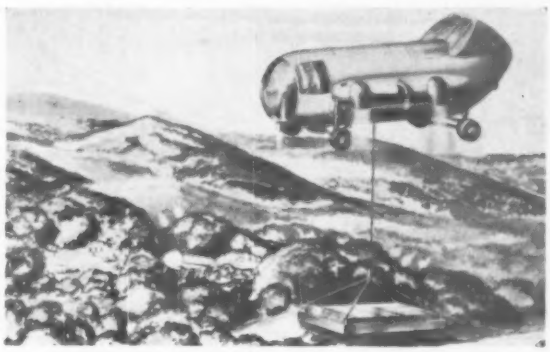
Many advantages are claimed for the BS.53 type of powered lift system when compared with the use of simple pure-jet lift engines. It makes possible the design of single-engined VTOL aircraft and of multi-engined types in which the whole of the installed thrust is available for vertical lift.

With the BS.53 the ground-running problems of recirculation, debris ingestion and ground erosion are reduced, because ground running can be done with the exhaust discharging horizontally. A VTOL aircraft with this engine can be taxied conventionally; at take-off a short forward roll before the nozzles are deflected downwards will ensure that dust and debris are left behind. The low temperature and velocity of the exhaust—typical of a ducted fan—help reduce noise and ground erosion caused by the engine. According to Bristol Siddeley, the BS.53 "makes about half as much noise as a turbojet of comparable power."

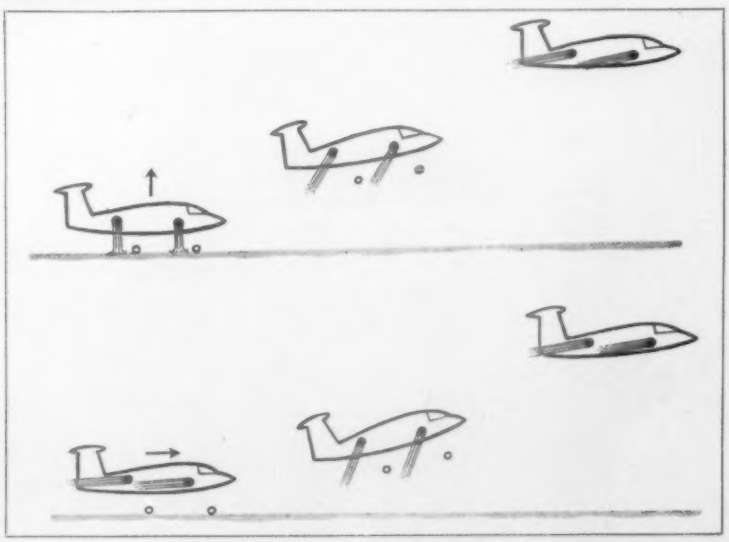
The BS.53 is installed conventionally with a forward-facing air intake. As a single powerplant giving both VTOL and cruise thrust, it has obvious maintenance, operational and logistic advantages for tactical warfare. If a BS.53-powered aircraft is designed for VTOL operation, it will be able to take off at a considerable overload after a short ground run. This allows the ferry range, military load or endurance to be extended greatly if the aircraft operates from a conventional runway.

Studies have been made of VTOL and STOL transports using this engine. As with the fighter, they could operate in the VTOL rôle with a normal payload, or lift a considerable overload when runways are available.

Pictures on next two pages.



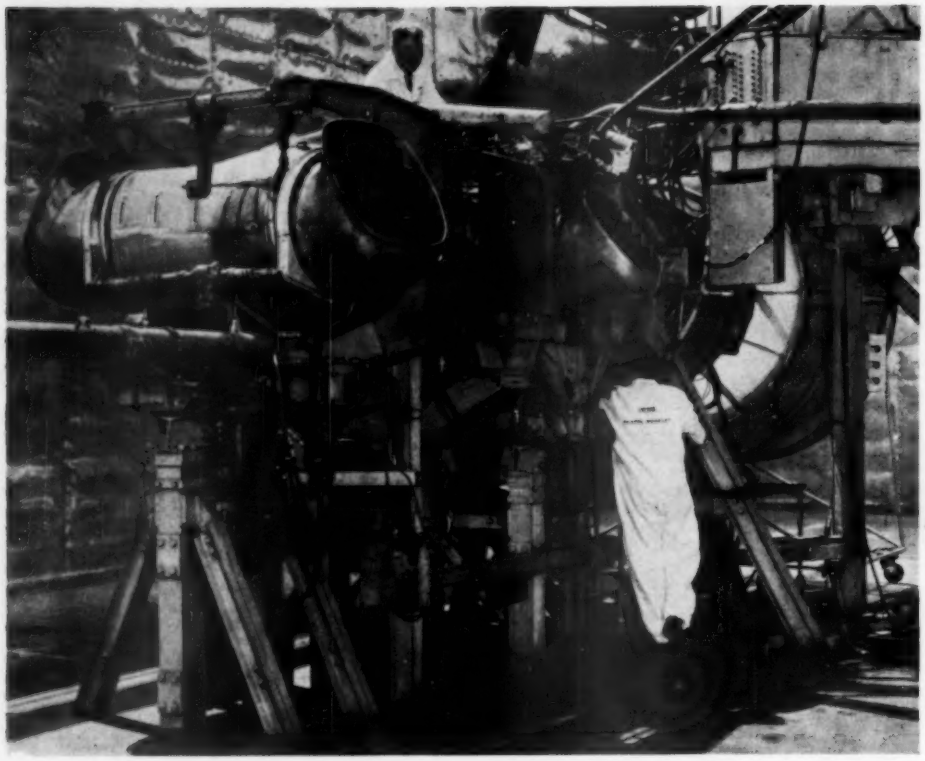
JET-LIFT VEHICLE.—This wingless jet-lift vehicle proposed by Bristol Siddeley could carry heavy loads and cruise faster than a helicopter. It relies on an engine of the BS.53 type.



VTOL AND STOL.—Positions of BS.53 jet nozzles during stages of a vertical take-off (upper view) and short take-off (lower view) are shown below. For a short take-off the initial run is made with full aft thrust; the nozzles are then lowered rapidly to give a large lift component.

Bristol

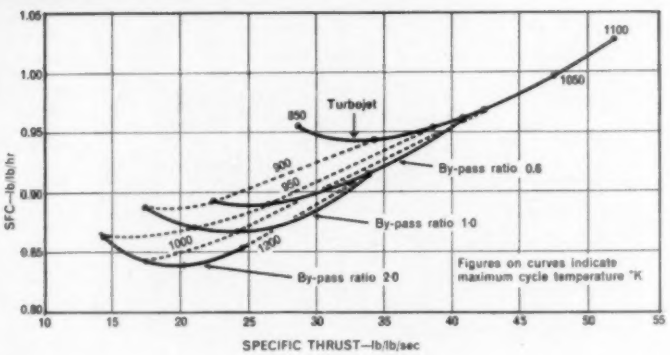
First photographs of the BS. of this front-fan lift-thrust the first operational VTOL Hawker P.1127. The engine

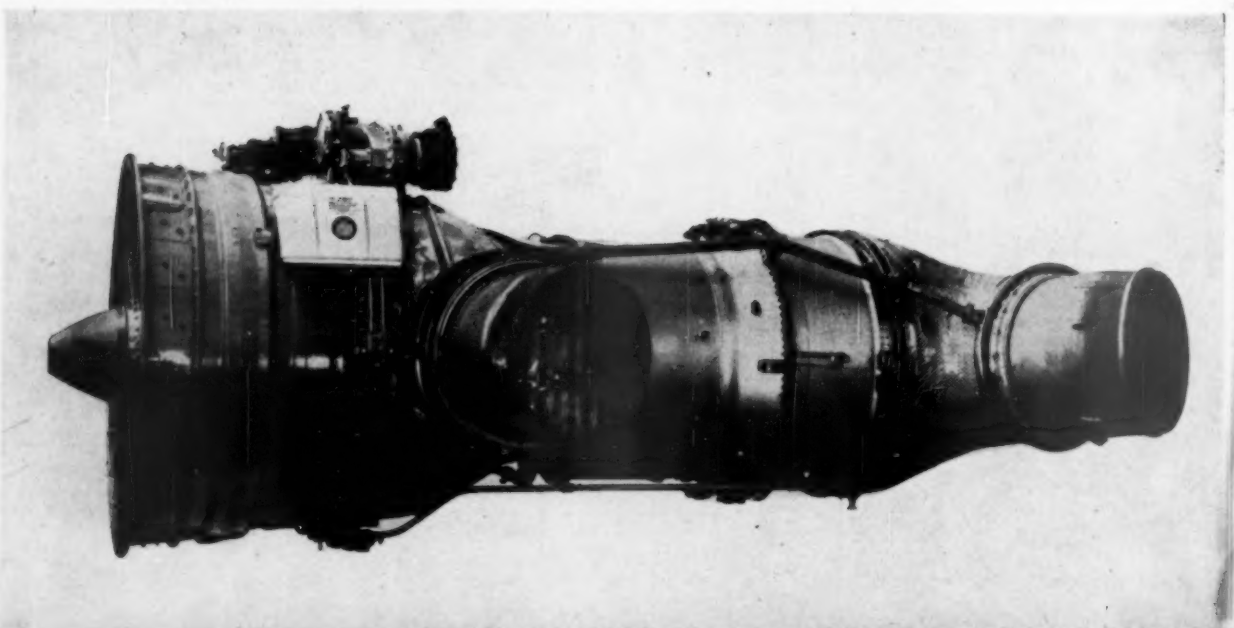


TEST BED.—For test running the engine is inverted, so that the jet nozzles exhaust upwards when in their lift position—as seen here.

LOW CONSUMPTION.—Advantages of a high by-pass ratio in giving a low specific consumption are indicated on the right. By-pass ratio of the BS.53 is probably between 1.5 and 2.

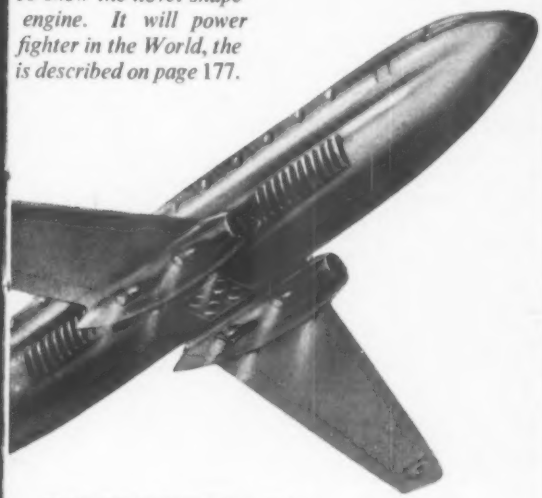
MILITARY VERSION.—The side view of the BS.53 suggests that this engine is closely related to the civil BE.58 ducted fan (extreme right).



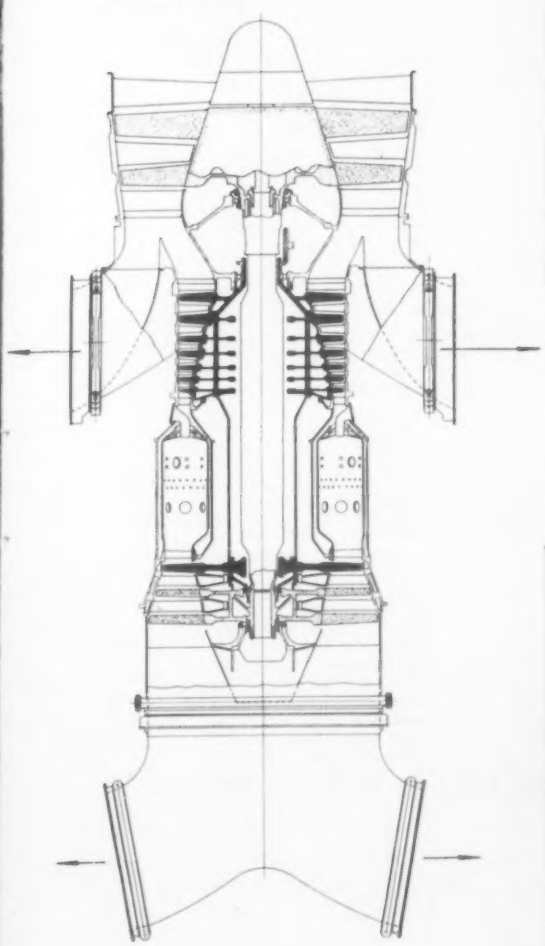


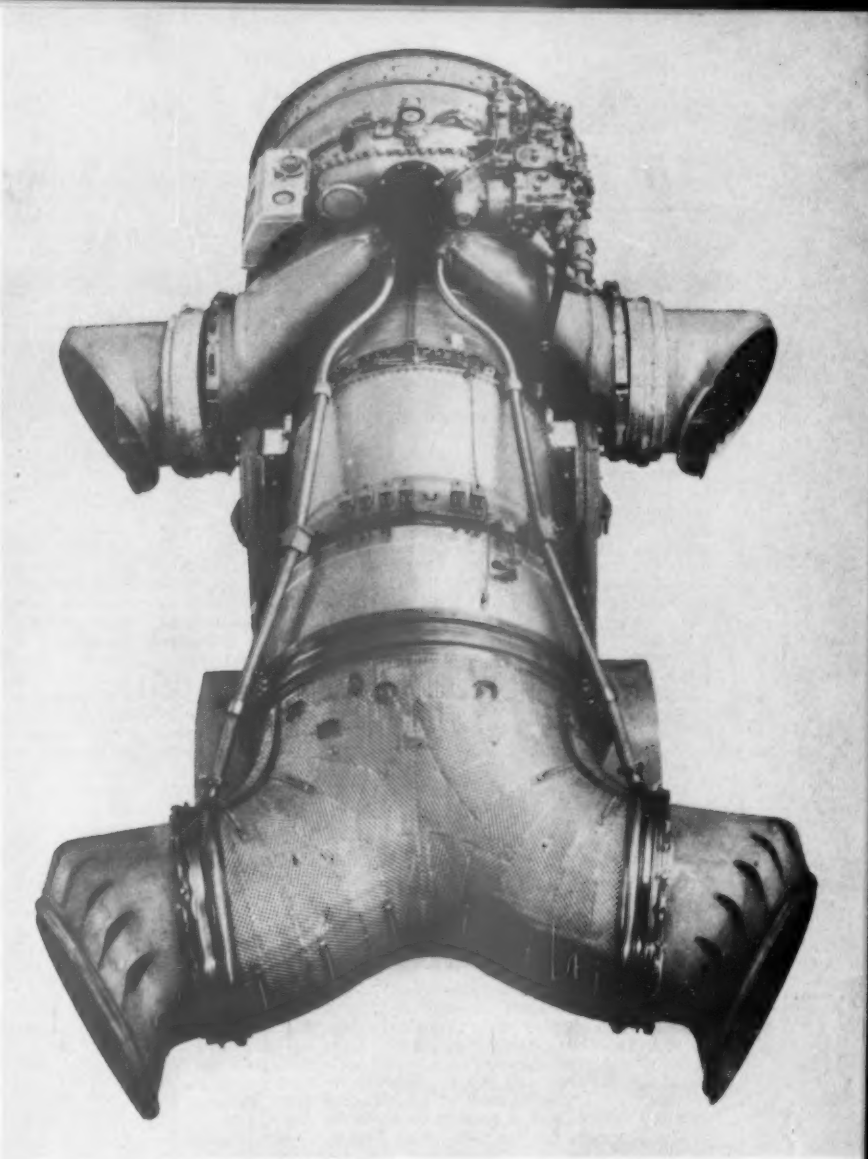
Siddeley BS.53

53 show the novel shape engine. It will power fighter in the World, the is described on page 177.



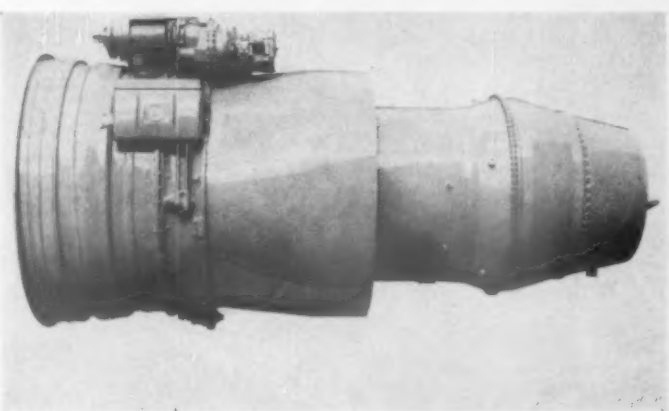
TRANSPORT PROJECT. — This artist's impression shows a projected VTOL transport with two BS.53s and four jet-lift ducted-fan engines.





FOUR-WAY THRUST.—Jet nozzles of the BS.53 point to the rear to give propulsive thrust; they can be revolved through 90° to give a lift thrust, or to intermediate angles to give both lift and thrust. The drawing on the left is from a paper by Dr. S. G. Hooker; it probably shows the internal layout of the engine.

CIVIL DUCTED FAN.—The BE.58 ducted-fan engine which was exhibited at Farnborough last year by Bristol Siddeley bears a close resemblance to the basic BS.53.



Air Transport

"We Don't Want to Fight..." *

NOT unnaturally Sir Matthew Slattery used his first Press conference as newly appointed chairman of B.O.A.C. to clarify his (and B.O.A.C.'s) views about the supersonic transport. He said, in effect, that its economics and passenger-appeal were doubtful quantities, but that it would come anyway; that B.O.A.C. must not be left behind in the inevitable race for supremacy; and that the winning of this race might involve the introduction of supersonic transports by the Corporation even before 1970.

Despite the fact that none of the carriers appears to want a supersonic transport—or, at least, not before the mid-1970s—Sir Matthew was not optimistic about the prospects of any agreement to hold back on the decision to order, but hoped that it might be possible to agree to, say, a 10-year advance notice of intention to operate such aircraft.

It was essential, said Sir Matthew, that the Government should quickly take the British studies to the next stage by agreeing on the speed and size and by selecting a group to go to work and to produce detailed aerodynamic and structural estimates. B.O.A.C. was ready to produce, within a matter of weeks, a specification or series of specifications so that a basic design could be formulated. It would be eminently sensible for the U.K. to join with the U.S.A. in producing one supersonic airliner for the western world to compete with anything which the U.S.S.R. was likely to offer; but there would need to be a genuine sharing of the work all the way through.

Sir Matthew said that there were three primary questions to be answered about the supersonic transport: what were the benefits; what were the economic prospects; and could the noise problems be solved? His answers to these three questions were, in fact, far from encouraging to the supersonic enthusiasts.

He doubted if there were any very appreciable benefits to the traveller in reducing the North Atlantic crossing time from seven to two and a half hours. The economic prospects depended on the number of aircraft which were likely to be wanted—and this, in turn, depended on the likely fares and on the uses to which the aircraft could be put. If, for instance, only 25 were wanted, and the development costs were £50 million, then each aircraft might cost about £5 million. Amortization over 10 years would thus be £500,000 per annum per aircraft—thus making the aircraft "hideously uneconomic." If the aircraft could be used on a World-wide basis, then 100-200 might be required and the costs begin to look rather more reasonable. The difference in amortization costs between 25 and 100 aircraft was equivalent to about 4d. per C.T.M.

The prospects for use other than over the North Atlantic—an obvious route for a start—depended partly on the solution of the noise problems. More jet noise just would not be tolerated by the public and the solution might well involve something much more basic than modification; this would increase the development costs still more. There was no answer yet either to jet noise or to the sonic bang. It would be uneconomic to operate the aircraft so that they were supersonic only over ocean areas and such a restriction would prevent the use of these aircraft on U.S. trans-continental services—which would reduce their usefulness, as well as adding to the difficulties of carriers who operated both over the North Atlantic and across the North American continent.

* ". . . but, by jingo if we do,
We've got the ships, we've got the men, we've got the money, too."
—G. W. HUNT, 1825-77.

Super Broussard Trials

A GOOD start has been made with the flight trials of the production version of the Max Holste Super Broussard, which flew for the first time on Jly. 29. Powered by two 930 h.p. Turboméca Bastan turboprops, this MH.260 is the second Super Broussard. The first, flown on May 20 last year, is powered by Pratt & Whitney R-1340 Wasp radials. The Bastan version is the production form of this 20-23-passenger light transport, on which Avions Max Holste and Nord Aviation are collaborating.

In the first six days of flight testing, the MH.260 accumulated 10 hr. 20 min. in the course of seven flights. In addition to general handling and performance measurement, these flights covered some preliminary single-engined flying, stall tests and investigation of the flaps and automatic feathering. The aircraft is now undergoing a maintenance check and undercarriage fairings are being fitted before flying is resumed.

No firm orders for the Super Broussard have been announced, but a number of airlines have shown practical interest. Apart from some of the French operators, these include Ansett-A.N.A. in Australia, which has reserved six of the first Super Broussard from the production line, subject to satisfactory certification. Latest data for the MH.260 given by the makers are as follows:—

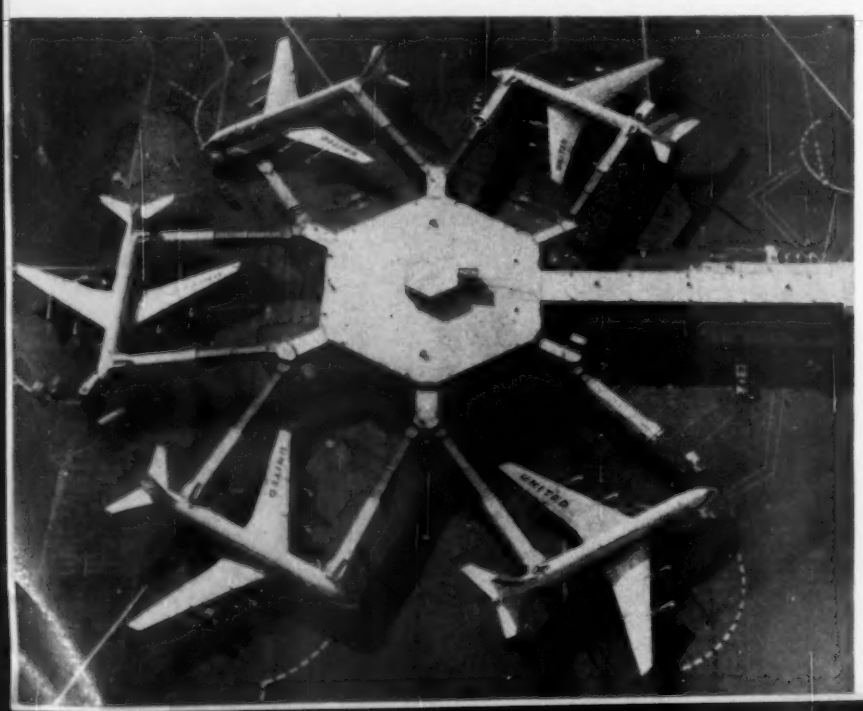
Basic operating weight, 12,345 lb.; max. t.-o. weight, 20,723 lb.; t.-o. to 50 ft., 1,295 ft.; initial climb, 1,670 ft./min.; cruising speeds, 189-205 knots; stalling speed (flaps down), 48.5 knots; landing distance from 50 ft., 1,280 ft.; field length required (SR422A-B at 18,077 lb. in I.S.A.), 2,190 ft.; landing field required (SR422A-B), 2,370 ft.

L.A.P. and the Non-Scheds

THE Ministry of Aviation has issued (C.A. Information Circular No. 81) some positive comments on the use of London Airport by non-scheduled traffic.

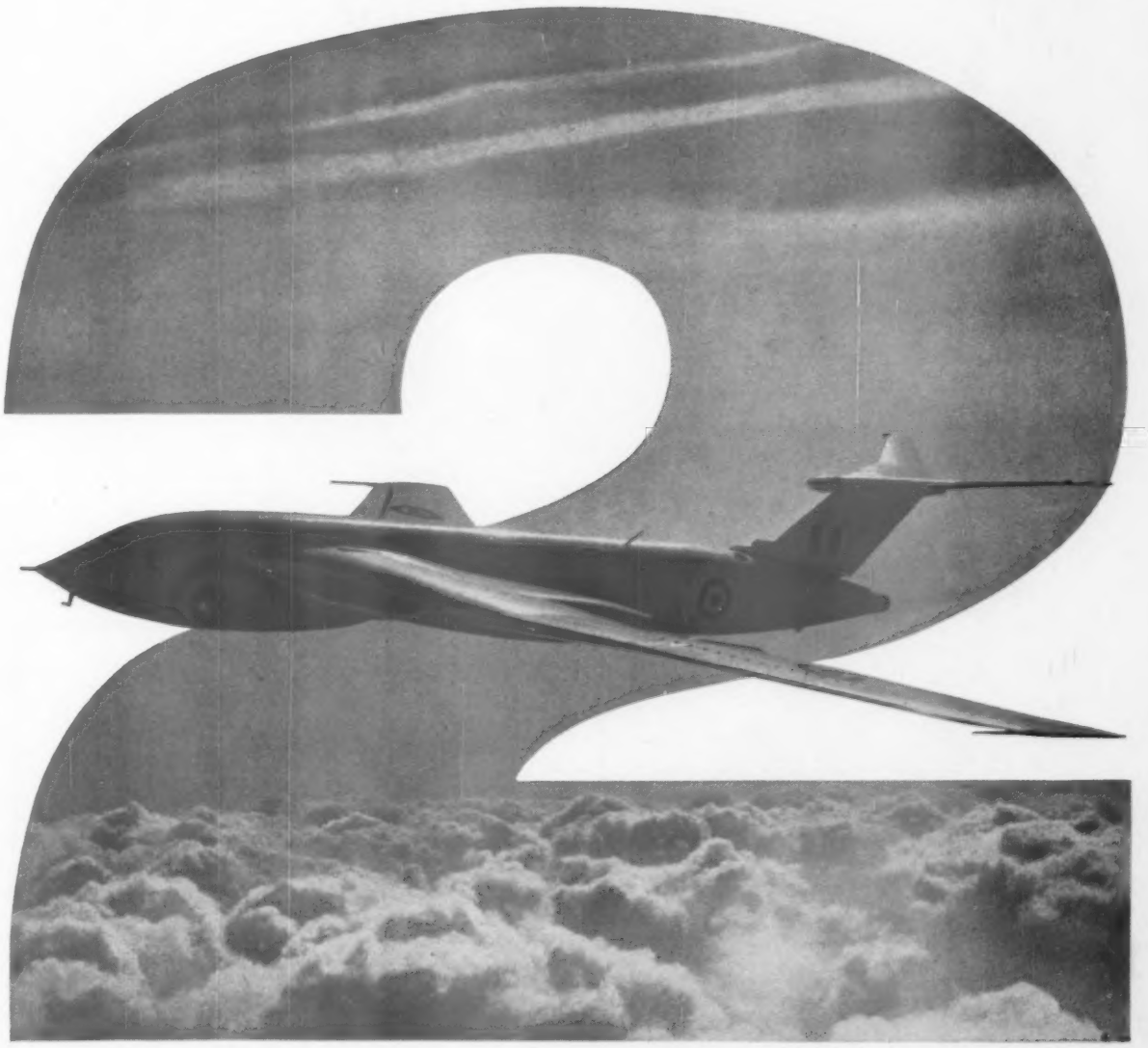
Permission for its use by such traffic will, the circular says, only be given in exceptional cases and no such permission will be given for operations by single-engined aircraft or for flights of a "recreational nature." Permission to use L.A.P. is unlikely between 0600 and 1100 hrs. or between 1500 and 1900 hrs. G.M.T. during the summer months.

At least 24 hours' notice (to Management Control, L.A.P.) must be given, with appropriate information under 14 headings. Applicants must have a nominated handling agent at the airport.



PINWHEEL TERMINAL.—A practical operational trend in airport ramp and apron design is demonstrated by this picture of United Air Lines' passenger terminal at San Francisco International. The five DC-8s are connected by telescopic "Jetways" to the concourse at the end of the finger which itself extends from the main terminal building.

mightier VICTORS will keep your peace



Victor 2s are even more potent versions of the sonic Victor 1s in V-bomber service with the Royal Air Force—and still the largest aircraft to have breached the sound barrier.

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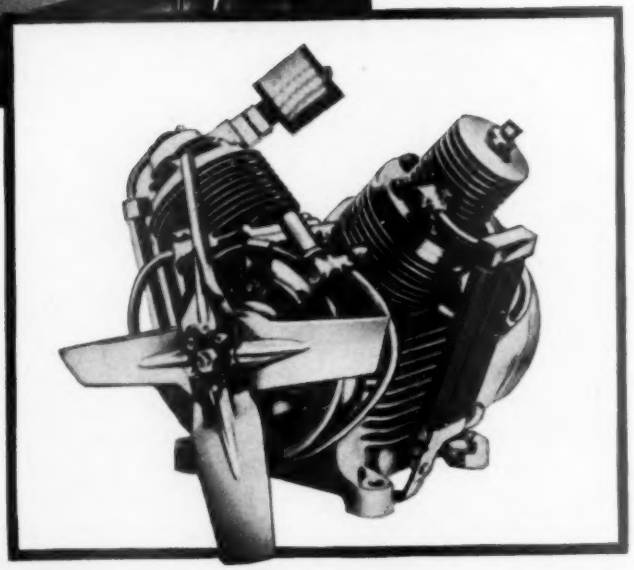
C

High pressure air supply for any application



The DUNLOP Pneumatic Charging Trolley was originally developed for ground-charging aircraft pneumatic systems.

The DUNLOP air-cooled Compressor mounted on the trolley is driven by a twin-cylinder petrol engine, with control panel; engine rating 6 h.p. at 3,000 r.p.m. Four types of compressor are available offering maximum working pressures of 4,000,1,000,600,250 p.s.i. respectively.

The compact unit, with alternative compressors, is suitable for any application requiring a high-pressure air supply.

DUNLOP

Pneumatic Charging Trolley

DUNLOP RUBBER CO. LTD., (AVIATION DIVISION),
FOLESHILL, COVENTRY Tel: Coventry 88733

HCD 237/AV

Air Transport . . . .

The Capital-United Merger

ALTHOUGH the term "merger" has been used of the plan negotiated by the boards of Capital Airlines and United Air Lines (see our previous issue, p.152), it amounts in fact to a take-over of Capital by United. If the plan is approved by the shareholders of the two companies and the C.A.B., the name of Capital would disappear and United Air Lines would probably be the largest of the U.S. domestic operators.

At the present time, United has a 14,000 route-mile system, operating primarily east and west across the continent and up and down the west coast. A small amount of international traffic is carried on routes from the west coast to Honolulu and across the north-west border to Vancouver. Capital has a 6,516 route-mile system concentrated in the eastern U.S. and serving many points south of Washington, which are not touched by United. In addition to giving United these important extra traffic points as far south as Florida, the merger would reduce competition on routes in the north-east, serving such points as New York, Boston, Washington, Pittsburgh, Cleveland, Detroit and Chicago, where both United and Capital operate at present. It is in this area particularly that Capital has felt the full weight of the jet competition from other airlines, and the 15 Capital Viscounts which would be made redundant if the merger were completed would presumably be withdrawn from these routes.

United Air Lines, with 23,310 employees, has a current fleet of 207 aircraft and 55 more on order, made up as follows: 40 DC-8 (including 26 delivered); 29 Boeing 720 (including eight delivered and 11 to be ordered shortly); 20 Caravelles (1961 delivery); 43 DC-7; 40 DC-6B; 42 DC-6; 35 Convair 340; seven DC-6A and six DC-7A Cargoliners. To this fleet would be added 41 Viscount 745 (with 15 more returned to Vickers) and some or all of Capital's 48 piston-engined aircraft: 10 L-049, 11 DC-6BT (leased from Pan American), 10 DC-4 and 17 DC-3. The Capital orders for seven Convair 880-22M and five Electras have been abandoned and the company has no new aircraft on order. At the end of May, the company had 7,840 employees; some redundancy will presumably result from the merger.

Financial details: The agreement between the two Boards provides for the shareholders of Capital to receive one share of United common stock and a five-year warrant to purchase 1½ shares of United at $40 per share for each seven shares of Capital common stock. An offer will be made to the holders of Capital's 4¼ per cent. convertible subordinated debentures of 12 shares of United common stock for each $1,000 principal amount of debentures. The agreement requires that not less than 85% of the $12 million of debentures must be deposited for exchange into United stock.

As recorded last week, Vickers-Armstrongs, Ltd., which is actively encouraging the plan, would receive as compensation for the Capital promissory notes it holds, $15.9 million of United 5½% cumulative preferred stock, 60,000 shares of United common stock, 7½ year warrants to purchase 200,000 shares of United common stock at $45 per share, and the 15 Viscounts (which might be assumed to have a market value of about £2 million). Shareholders of both companies are to vote on the plan by the end of October and the C.A.B. decision is expected by February, 1961.

The Air-freight Business

BAGGAGE containers which ride on a cushion of low-pressure compressed air to facilitate handling are now being used experimentally by T.W.A. on Boeing 707 flights between New York and Los Angeles. Developed jointly by Douglas Aircraft and T.W.A., this "new concept in containerization" (as the Press release puts it) may have applications for freight handling as well as baggage containers.

The aluminium containers, designed to fit the lower holds of the Boeing 707—six forward and three aft—each have capacity for about 1,200 lb. of baggage in 30 pieces. Swivelling Glide-Aire pads in the base produce an air cushion which reduces friction and allows the container to be moved rapidly and with little effort. Large folding doors on each side of the containers provide easy access for rapid loading and unloading.

These containers are moved to and from the aircraft on a train of flat dollies. At the aircraft a Jeep-mounted conveyor, with a moving belt, provides a ramp between the dollies and the cargo hold. The Jeep also carries a compressor to provide a source of air for the Glide-Aire through a small flexible hose.

With air cushion working, the container is moved manually off the dolly and on to the conveyor belt, and off the belt into position inside the aircraft (or vice versa), the air hose then being disconnected and attached to the next container. Small modifications have been made inside the aircraft, including a plywood sub-flooring fastened to existing cargo tie-down fittings to distribute the loading, and longitudinal guides along the edge of the floor to serve as container restraints and to carry the loads into the tie-down tracks.

In trials so far, the unloading time from engine shut-down to arrival of the last container in the baggage-claim area has been approximately eight minutes, but some modifications to the equipment are expected to reduce this to six minutes. Apart from the speed and ease of handling, T.W.A. claims that the system has the minimum weight penalty, simple components, requires minimum aircraft modifications and utilizes existing ground equipment.

From Russia comes some information on baggage-handling equipment recently introduced by Aeroflot. One is a conveyor belt on a GAZ-69 (Jeep-like) vehicle, which moves at 2½ ft./sec. and can accommodate individual items up to 160 lb. The angle of the belt is adjustable for use with the An-10, Il-18, Tu-104 and Tu-114.

For larger items of freight, several sizes of lorry with elevating platforms have been produced. Examples are the APK-4x4.2 which can lift 4 tons to a height of 4.2 m. (13.7 ft.) and the APK-6x4.5, which lifts 6 tons to 4.5 m. (14.7 ft.). A passenger transporter now in use at Vnukovo carries 16 passengers on the prime-mover and draws three 24-passenger trailers, making a total capacity of 88.

Another Russian development in air freighting is the use of air-dropped containers to deliver matrices of the daily papers from Moscow for printing and distribution at outlying centres. Until recently these matrices were airlanded, but much time is now saved by parachuting the containers from Li-2s, Il-12s, or Il-14s.

C.A.A.'s Improved Position

IN the 1959/60 financial year, Central African Airways improved its financial position by more than £240,000 compared with the previous year, when a loss of £169,000 was recorded. Provisional results announced in Salisbury show that a trading profit of nearly £70,000 was made after payment of more than £150,000 interest. A final net surplus of about £35,000 will be carried forward.

The number of passengers carried, 175,000, was 17% more than in the previous year, and freight increased by 12% to 1,850 short tons. Revenue increased by £280,000 while increased airport landing fees, aircraft insurance rates, fuel and oil costs and a staff salary award added up to £60,000 in extra costs during the year. A major effort was made during the year to promote inclusive tours to and from the Federation, with some success, and this campaign is continuing.

In the current financial year, starting on Jly. 1, C.A.A. is faced with a loss of nearly £500,000 revenue when the Zambesi service is withdrawn at the end of September. Some of the capacity made available will be utilized on additional regional and domestic services, but the company is budgeting only to break even in the year's operations. A guaranteed Government subsidy of £60,000 is being sought for 1960/61, although this may not be needed. For the 1959/60 year, a £160,000 subsidy had been voted by Parliament but was not taken up.

C.A.A. has declared its intention of increasing its Viscount fleet in order to operate only Viscounts on all the main routes. Dakotas will be retained on some domestic routes because of airfield limitations and the small traffic offering. The fleet at present comprises four Viscounts and six DC-3s in addition to five single-engined Beavers.

With compressed air fed from the Jeep on which the loading ramp is also mounted, a baggage container with Glide-Aire units is moved into the rear hold of a Boeing 707.

SPACE FLIGHT SURVEY

To anticipate the opening of the Eleventh International Astronautical Congress in Stockholm we are publishing this sixteen-page supplement of exclusive material. Besides the articles by experts in their own fields, the major portion is devoted to copyright illustrations of astronautical hardware and tabulated performance data, the whole making the most complete survey published to date.

A Projected Communications Satellite

This article, specially written for THE AEROPLANE AND ASTRONAUTICS by William Frank Hilton,* D.Sc., Ph.D., A.R.C.S., D.I.C., F.R.Ae.S., F.B.I.S., is the first to describe Hawker Siddeley project work on communications satellites.

ONE of the most surprising results of our studies at Hawker Siddeley Aviation on the communications satellite has been the complete abandonment of the 24-hr. equatorial, or "stationary," orbit. No particular use could be found for this stationary property, which demands a combination of good shooting and orbit correction to maintain a satellite accurately on station over the years. Moreover, there would be a time lag in telephone conversation, due to the finite velocity of light, of approximately 250 milliseconds. This is well outside the standard set up for international telecommunications.

It was therefore decided to make a virtue out of necessity (considering the performance/payload capability of Blue Streak and Black Knight) and to employ moving orbits closer to the Earth with greater load-carrying capacity, yet requiring less-powerful radio to cover the intervening distance. In this way it is possible for a satellite to transfer telecommunications from one part of the Earth to another according to a daily rota and to bring extra communications at the peak period of the day to each place in turn.

Method Used

It is proposed to establish communication between two cities, say London and New York, by collecting 100 telephone calls together at each end and to employ a powerful transmitter at a frequency of about 1,000 megacycles with a bandwidth of 1 megacycle. This transmitter would be directed at the satellite which would receive the signal and, after amplification, re-transmit it to its destination. It is, perhaps, useful to consider the historical side of radio at this point and to examine the reasons why we have deviated from the straight-line propagation which was in the minds of the pioneers.

* Head of the Astronautics Division, Advanced Projects Group, Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames.

Practical radio started in 1885, when Hertz produced centimetre wavelengths and showed they followed the reflection and refractive laws of light, and used parabolic dish reflectors. Straight line-of-sight radio propagation is of small value on the surface of a spherical World, and Marconi overcame the Earth's curvature by reflecting longer wavelengths off the ionized layers in the upper atmosphere.

The Static Problem

Compared with the cable and its many submarine repeaters, radio is cheap, but is often "nasty" due to sunspot disturbances. Clearly, a space radio relay station would enable us to use reliable straight-line propagation at Hertz's higher frequencies, right up to 11,000 megacycles, where water vapour in the Earth's atmosphere absorbs too strongly.

How high should this space-station be placed? Aerials on masts lack coverage due to the Earth's curvature, whilst a remote station millions of miles away would need enormous power to combat the inverse square law, although securing excellent coverage of nearly half the Earth's surface.

This compromise between coverage and attenuation can be

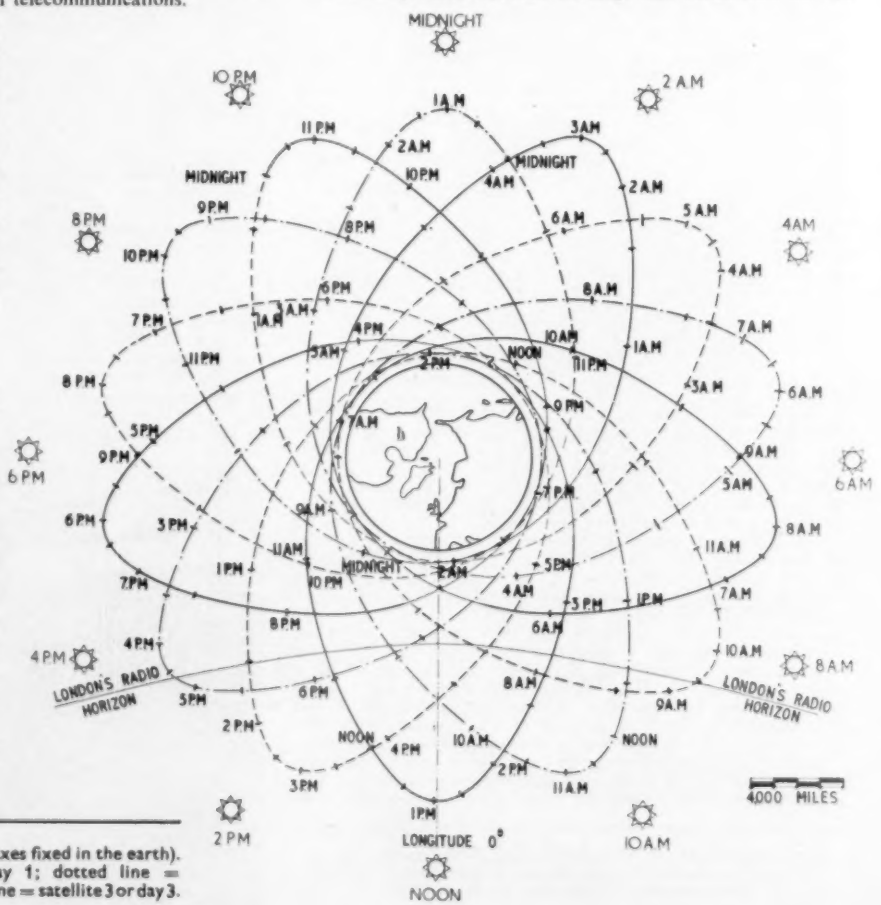


Fig. 1. The "n = 4 Rosette" (axes fixed in the earth). Solid line = satellite 1 or day 1; dotted line = satellite 2 or day 2; chain-dotted line = satellite 3 or day 3.

worked out mathematically to find a station situated at about one Earth diameter (8,000 miles) altitude which combines good coverage with economy of radio power.

Let us, therefore, consider possible orbits giving service at 8,000 miles altitude. The equatorial, polar and inclined circles at this height merit consideration. The orbit time will be 6 to 8 hours, but only some 2 hours of this time will be available to the country which paid for the satellite.

Use of Elliptical Orbits

This fact, combined with the difficulty of achieving " re-light " for launching into circular orbits, leads to the consideration of elliptical orbits. A perigee of 200 miles would give a lifetime of, perhaps, 20 years, but atmospheric drag would reduce the apogee height; increase to a 300-mile perigee gives an orbit that is both permanent and stable from an air-drag point of view. A six-hour orbit would have an apogee height of 12,600 miles, and spend more than 70% of its time usefully on one side of the Earth (Kepler's " equal area in equal time " law).

We shall see how three satellites can cover either part of the World all the time, or all the World for half the time.

Communications Peaks (A) Temporal

Communications show a peak during the hours of sunlight, so that our ellipse should have an apogee aimed towards the Sun. The satellite will then linger more than 70% of its time on the sunlit side of the Earth, and dash past the sleeping side of the Earth under perigee conditions, to return rapidly to service near apogee.

As the Earth rotates inside this orbit, the satellite will continue to bring communications on the sunlit side. The effect will be as if we could transfer the Atlantic cable to the Pacific each night, and bring it back to the Atlantic next morning ready for use.

If intermittent coverage is to be given in this way, it should occur at the same time each day, so that the orbit should be exactly an integral number of times per day, such as 4, 5 or 6 times. If a slight error of, say, 1 minute per day is made in launching, this would cause the satellite to gain until it was

Fig. 2. Equatorial Radio Horizons for a number of cities.

half an orbit period fast, when it would also be half an orbit slow, and come into good synchronization again later. Thus, errors in period would be relatively unimportant.

If an ellipse in the equatorial plane is to be kept pointing towards the Sun, it will have to rotate exactly once per annum. We propose to use the perturbation due to the Earth's equatorial bulge to bring this about.

No solution is possible for 1, 2, 3 or 4 orbits per day, but $4\frac{1}{4}$ orbits per day gives the correct 0.986° perturbation per day (=360°/365.24). A 5 times per day orbit must be inclined at 12° to the Equator, and a 6 times per day at 27°, for 300 miles perigee heights.

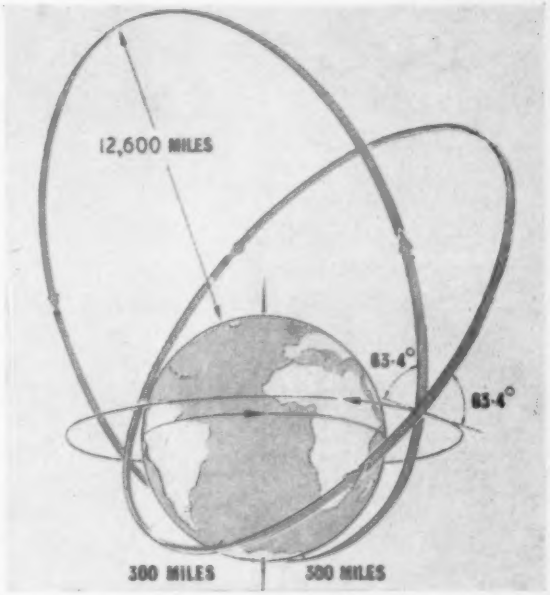


Fig. 3. Elliptic orbits in 63° slot.

By far the best solution is to use the $4\frac{1}{4}$ times ellipse, so that a satellite goes round 14 times in exactly 3 days.

A second satellite is used on the second day, and a third on the third day, so that each satellite is " on duty " once every 3 days. Fortunately, the " off-duty " satellites, whose orbits are already exactly defined, supplement the " on-duty " satellite to give a 12-hour continuous coverage per day to London, and a better coverage to places nearer the Equator.

Fig. 1 presents the case pictorially; in this the Earth has been artificially brought to rest, so that the Sun appears to rotate round it, and the 14 satellite orbits are displayed as the 14 lobes of the figure, which we term a " rosette."

Due to the Earth's curvature, London cannot " see " the Equator, and it has a radio horizon on the equatorial plane, as indicated. All satellites beyond this line can be " seen " from London.

The horizons for other cities are shown in Fig. 2. A satellite must be above both horizons to allow communication between two cities, otherwise an intermediate relay point must be used, plus two satellites.

These orbits will, of course, be slowly perturbed by the Sun and Moon, and the " older " satellites will give communications to other places or at other times.

The orbital repeaters will also have to be replaced by new satellites from time to time.

Such effects are being calculated but are not thought to be important.

Communications Peaks (B) Spatial

We have seen above how to cover peak times, but the Northern hemisphere contains most of the World's cities.

If we place communications satellites with their apogees over 63° N., as indicated in Fig. 3, the perturbations will cause the orbit to rotate, with its apogee always over 63°.

This type of orbit will favour London in comparison with that shown in Fig. 2, as it climbs much higher in the sky.

One satellite gives $9\frac{1}{2}$ hours per day coverage on the London-New York link, and three should provide a 24-hour coverage from the North Pole right down to latitudes of about 40° N.

Design of Satellite

The orbits described above should, we feel, be used for future communications satellites, regardless of weight or power. Using Blue Streak, Black Knight and an efficient third-stage rocket, we find from published information that some 650 to 720 lb. can be put into these orbits. This appears to be nicely suited to the task in hand, and a suggested design is shown in Fig. 4.

Solar energy is turned into electricity by four large arrays of solar cells, opening out like an umbrella. The array is designed to be insensitive to direction of the sunlight over a wide range of angles.

The satellite is attitude-stabilized so as to point a radio dish in its base towards the Earth. This gives a 10 db gain at all radio frequencies.

Attitude stabilization is first achieved by small H.T.P. rockets,

and electric motors driving flywheels take over the fine control. The rotational momentum of the satellite may be said to be stored in these flywheels.

A radio power of 45 watts is envisaged, for 1 Mc/s bandwidth. Later developments will expand the bandwidth to 5 Mc/s suited to relay of T.V. This will open up fresh possibilities for Commonwealth T.V. services. The problem of long-distance telephone and T.V. communication is essentially British (or French) rather than Russian or American.

Economics of Operation

Needless to say, the rockets and satellites will require development before being suited to their purpose. A complete assembly would probably cost £800,000, say £1.3 m. including failures.

Thus for £4 m. we could expect to cover the Northern hemisphere in competition with the £88 m. cable designed to last 20 years. If the satellite life is one year, the two would be economically competitive.

If satellite life-times of the order of 20 years can be usefully achieved some years hence, the satellite will *reduce costs by a factor of 20 times*. Thus £1 a minute 'phone calls will be 1s. a minute, or 6d. a minute if rocket reliability has improved.

This opportunity seems too good to ignore. Are we going to do it with British hardware, hardware which is now not earmarked by prior military claims? Time, and the politicians, will decide the answer.

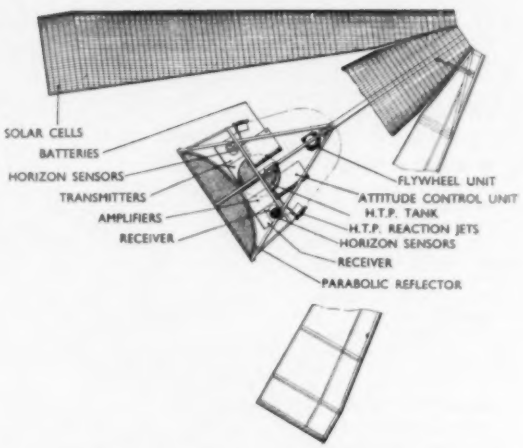


Fig. 4. Hawker Siddeley Communications Satellite.

Bristol Siddeley Stentor for Blue Steel

A BRAND-NEW rocket motor, the Stentor, manufactured by Bristol Siddeley, is to power production versions of the Avro Blue Steel stand-off bomb. News that the Stentor is the powerplant for production Blue Steels may come somewhat as a surprise to those who understood that the missile was powered by a de Havilland Double Spectre. But the de Havilland rocket motor is only used for full-scale aerodynamic test vehicles of this missile. Stentors are in quantity production at Coventry for operational Blue Steels.

The BSSt.1 Stentor is a two-chamber HTP/kerosene rocket motor. Its upper chamber has a nozzle exit area approximately four times greater than that of the lower chamber. No performance figures or dimensions are available for the Stentor, but its total thrust will generally be assumed to be greater than the 16,000 lb. of the Double Spectre, which consists of a fixed-thrust Spectre 4 mounted above a variable-thrust Spectre 5.

It could be that a similar system is used for the Stentor, with a large high-thrust chamber mounted above a smaller variable-thrust chamber. In this way both chambers could be used at full thrust to give the initial boost to accelerate the missile rapidly to its supersonic cruising speed. Thereafter the fixed-thrust chamber could be shut down for the missile to cruise on the thrust of the lower chamber. Its thrust could be reduced to maintain a constant cruising speed as propellents were consumed and the weight of the missile was reduced.

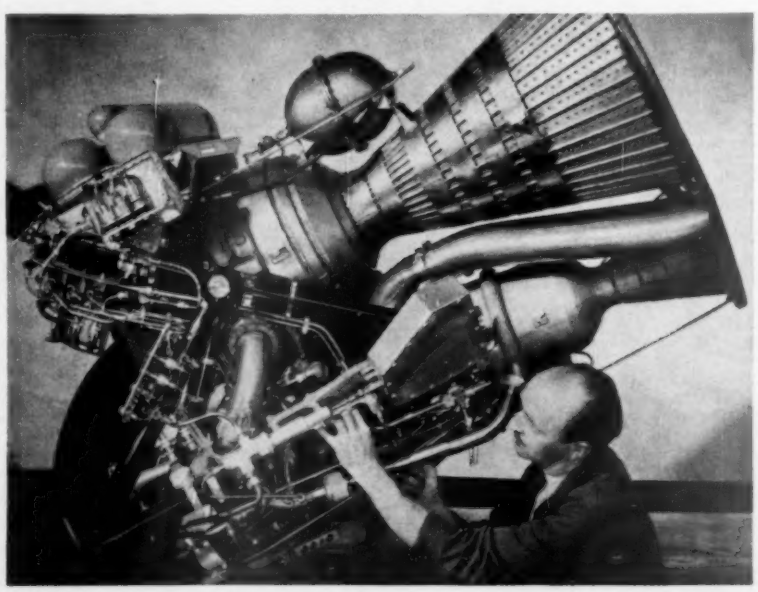
Turbopumps supply HTP (high test peroxide) and kerosene to the combustion chambers. The HTP passes through a catalyst pack, which decomposes it into a mixture of oxygen and superheated steam, before entering the combustion chamber. Kerosene is injected into this mixture and ignites spontaneously.

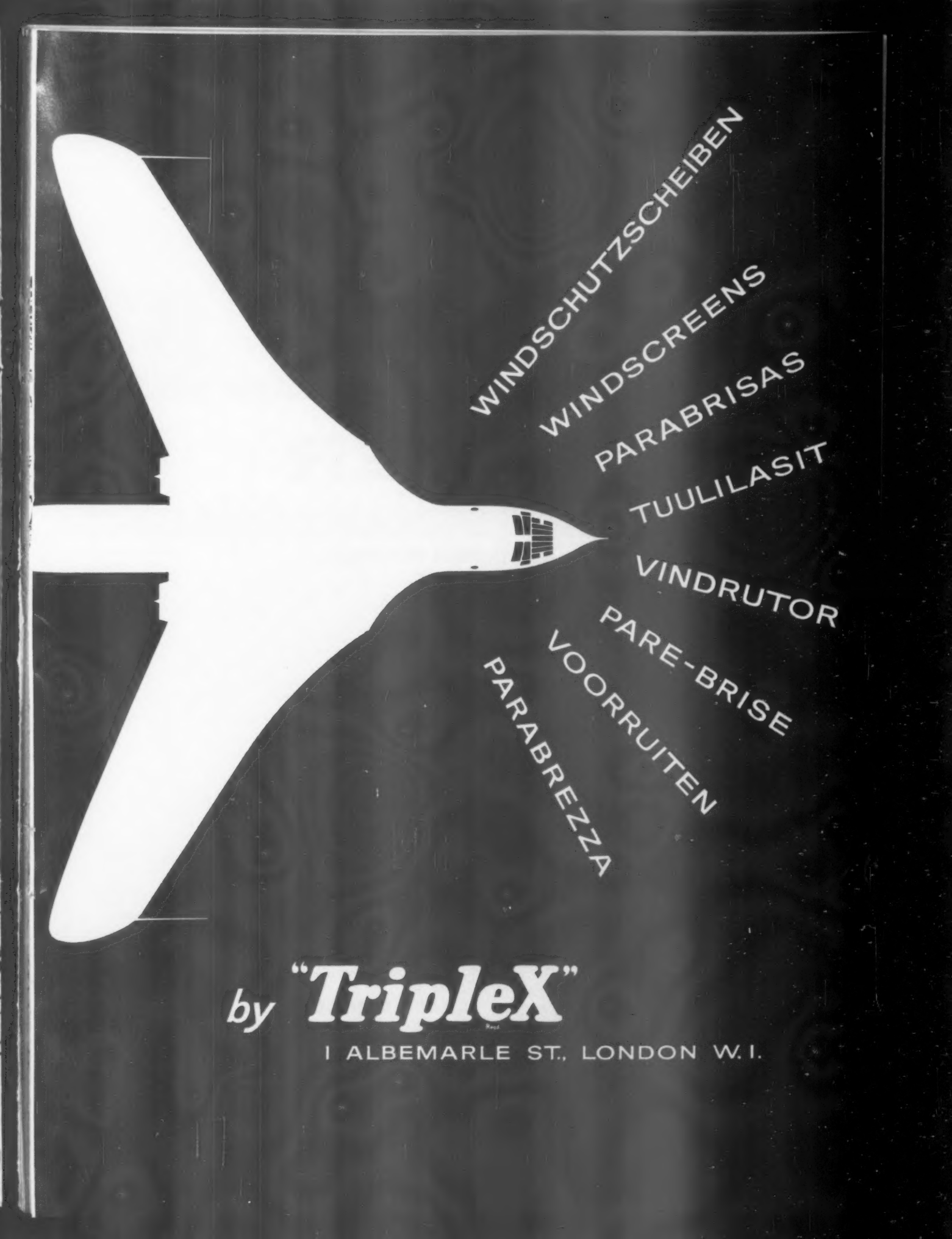
The expansion nozzles are regeneratively cooled by the HTP supply, which passes down to the end of the nozzle and back to the top of the chamber through passages in its wall before entering the catalyst packs. The HTP system is dried out with hot air after test firings in order to keep the engine in good condition during storage.

The engine is started by using pressurized nitrogen to drive HTP from a starting tank to a catalytic generator which supplies steam to the turbopumps. When the turbine reaches a sufficiently high speed, HTP is supplied direct to the steam generator from the pumps.

The Bristol Siddeley rocket division at Ansty was founded in 1946; it has specialized in liquid propellents and has had extensive experience of both liquid oxygen and HTP as oxidents.

Its Snarler rocket motor was test-flown in 1950-51 on the Hawker P.1072; this motor produced 2,000 lb. of thrust at sea level. The Siddeley liquid-oxygen/kerosene Screamer, whose development was ended in 1955, gave pilot-controlled thrust which was variable between 800 and 8,000 lb. The Bristol Siddeley rocket powerplant which is best known today is the Gamma 201 "four-barrel" motor which powers the Black Knight re-entry research vehicle. To date seven Black Knights have been launched, all successfully. This HTP/kerosene motor has a total thrust rising from 16,400 lb. at sea level to 19,000 lb. outside the atmosphere.





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New Soviet Space Projects

WITHIN two months, the Russians are expected to conduct at least one major space experiment. In the first week of October, Mars will be favourably placed in respect to the Earth for a minimum-energy transfer mission, employing the classical Hohmann orbit. However, this is not to say that this will be the launching date actually selected for as our article, "Probes to Venus and Mars,"* has already shown, late August is a reasonable period to choose if minimum-energy requirements are not involved. If propaganda considerations predominate, we may even find a Russian Mars-probe launched during the time of the I.A.F. conference in Stockholm (Aug. 15 to 20), bearing in mind the large multi-stage rockets that now exist in the Soviet Union.

In this, use would undoubtedly be made of a launching rocket of the type recently test-fired from Soviet territory into the Pacific Ocean. If it is intended to pass within a few thousand miles of Mars, the probe will certainly contain mid-course guidance equipment and a rocket engine for applying corrective thrust.

The Russians have also spoken of further probing shots to the Moon and possibly will soon attempt a soft-landing of an instrument package.

Man in Space

In assessing the future course of the Soviet space-programme, one must also remember that, despite certain conflicting statements by Russian scientists, a great deal of effort is being devoted to putting men into space. When Lunik I was launched into orbit round the Sun on Jan. 2, 1959, the President of the U.S.S.R. Academy of Sciences announced the existence of a seven-year programme to put a man on the Moon.

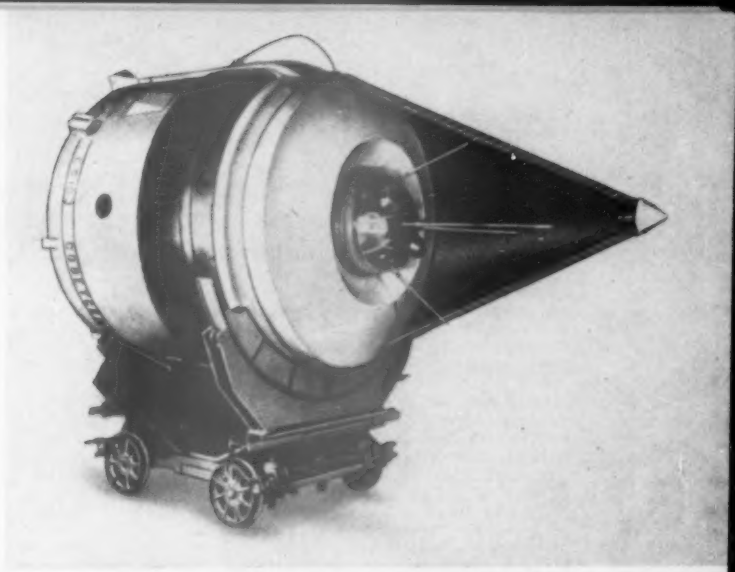
How seriously this programme is being pursued in Russia can be gauged from the impressive experiment of May 15 this year when a 10,010-lb. spacecraft (Sputnik IV) was placed in orbit (see pull-out table in this issue). Although we have not been permitted a glimpse of this vehicle, it has been described by *Tass* as a prototype spaceship, complete with pressurized cabin and "dummy" astronaut. It is also said to contain two-way communications equipment and sun-seeking solar batteries for power supply.

Although a fault in the orientation system prevented the Russians from claiming complete success for Sputnik IV, it must be regarded as a most important achievement. Exactly what it represents is, however, still somewhat obscure. The Russians reported that a 5,512-lb. pressurized cabin was designed to separate from another component of the vehicle. That this actually happened has been verified by American tracking stations (the two components, wrongly angled at the time of firing the retro-rocket, were sent into a higher orbit instead of being returned into the atmosphere).

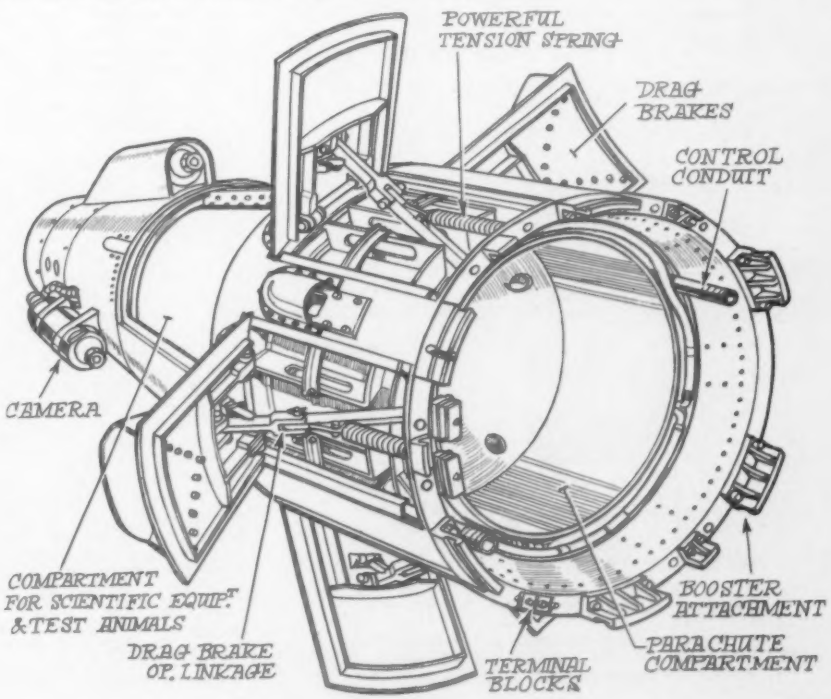
It appears that separation of the pressurized cabin occurred just after the retro-rocket fired. This suggests that the rocket was mounted not in the cabin structure but in the attached instrument compartment.

What is not so evident is whether the cabin was designed to make a purely ballistic re-entry (the Russians said the test-version would burn up in the atmosphere), or whether in fact it is being developed as part of a recoverable spacecraft with lifting properties. It is tempting to suggest that the Soviet vehicle may be one stage ahead of the American Mercury ballistic capsule in having minimum lifting surfaces, enabling it to glide in the upper atmosphere after re-entry before its cabin is released, at a suitably reduced velocity, for recovery by parachute.—K. W. GATLAND.

* By Stewart Greenwood, THE AEROPLANE AND ASTRONAUTICS, Dec. 4, 1959.



A mock-up of the final stage of Lunik I with the 800 lb. spherical probe inside the detachable nose-cone.



This copyright drawing, specially prepared for "THE AEROPLANE AND ASTRONAUTICS" by J. H. Clark, A.R.Ae.S., shows the detached head of one of the Soviet geophysical rockets used to carry scientific instruments and test animals (dogs and rabbits) to altitudes of 100 to 300 miles. After separation from the single-stage boost rocket, the re-entry head is slowed by petal drag brakes and is finally recovered by parachute.

The first official account of the Government-sponsored design-studies to adapt Blue Streak and Black Knight for the purposes of satellite-launching.

A British Space Booster

By E. C. Cornford, B.A., F.R.Ae.S.*

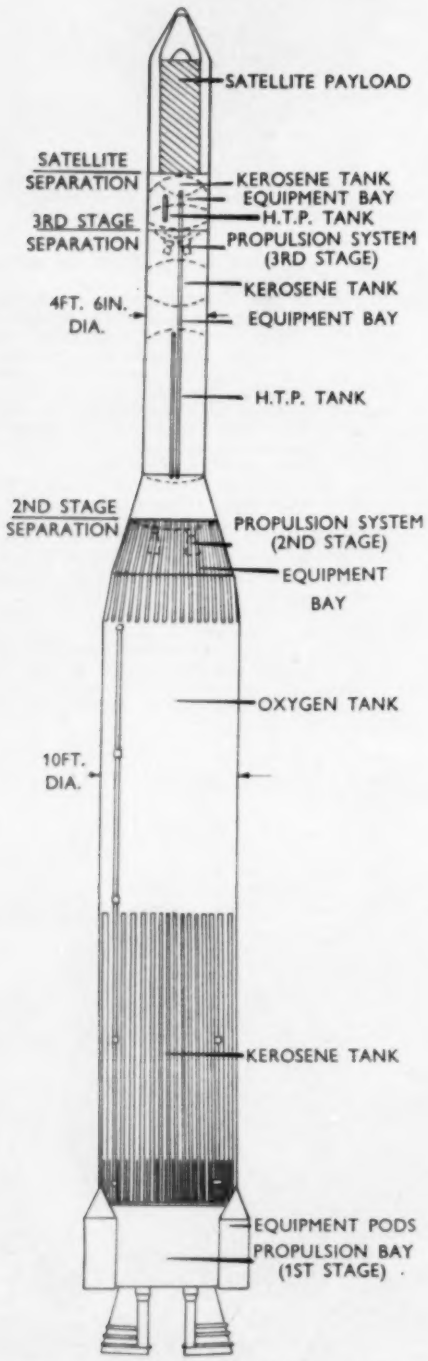


Fig. 1. Satellite launching vehicle based on Blue Streak and a modified Black Knight, from the R.A.E. proposals.

BLUE STREAK, with more than a hundred tons of thrust at launch, is potentially capable of providing the first stage for a satellite launching vehicle of great versatility and power. Following the Prime Minister's statement in May, 1959, that an investigation would be made of the adaptation of British rockets for satellite launching, extensive studies of these capabilities have been made at the Royal Aircraft Establishment, Farnborough, in collaboration with Saunders-Roe, Ltd., and, latterly, with the de Havilland Propeller Co.

One of the boundary conditions of these studies has been to make the greatest possible use of existing equipment and facilities, including the rocket ground-testing and development facilities at Hatfield, Spadeadam and in the Isle of Wight, and also the launching and other range facilities at the Weapons Research Establishment, Woomera, so as to minimize the cost of any future programme which might be undertaken. This has meant that modifications to the Blue Streak weapon, other than the stripping away of its essentially military characteristics, should be kept to the absolute minimum, and also that Black Knight, either as it now exists or, again, with the minimum amount of modification, should provide the second-stage rocket.

Before discussing some of the technical problems posed in the design of a satellite launching vehicle it is necessary to establish its "operational requirement." This has been derived, in consultation with members of the British National Committee on Space Research and its sub-committees, mainly from the possible future needs for scientific investigations outside the Earth's atmosphere. These needs have been condensed into three broad capabilities. They are to provide the means of launching:—

(i) A large satellite of the order of one or two thousand pounds weight into a near-circular, near-Earth orbit. This satellite would require accurate stabilization in space axes, and its primary purpose would be to carry an ultra-violet telescope and spectrograph for studying the ultra-violet radiation from the stars.

(ii) A smaller satellite of several hundred pounds weight into an eccentric orbit traversing the region out to two or three Earth radii, for the investigation of the Earth's gravitational, magnetic and radiation fields, and of the constitution and properties of the Earth's outer atmosphere.

(iii) A satellite of weight of the order of a hundred pounds into a highly eccentric orbit reaching out to about 100,000 miles, to carry instruments for the study of the Sun's atmosphere.

In each case a perigee height, or constant orbital altitude for the circular orbit, of 300 miles has been assumed in order to ensure an orbital lifetime of at least one year. The projection velocities corresponding to these three tasks are, respectively, about 25,000 ft./sec., 30,000 ft./sec. and 35,000 ft./sec.

These widely different requirements must obviously lead to differences in the launching vehicles which will meet them, but the need to devise means for achieving them which have as much "hardware" in common as possible has been a guiding principle throughout the studies.

Of the wide variety of upper-stage configurations which might be considered for use in conjunction with Blue Streak, the obvious one which first merits examination is the possible use as the second stage of the well-proven Black Knight rocket. This combination is potentially capable of projecting a substantial payload into the near-Earth circular orbit, but would require an additional rocket stage or stages to meet the higher velocity eccentric orbit requirements.

It is recognized that Black Knight, without modification, is not particularly well matched as a second stage for Blue Streak because its propellent capacity is below the optimum for maximum satellite payload for the combination. It would be preferable, if possible, to leave some of the propellents out of Blue Streak and provide additional propellents for the second stage. The use of Black Knight as a second stage would necessitate considerable strengthening of the tank structure, because the loads it would have to carry would be much greater

* Head of the Guided Weapons Dept., R.A.E., Farnborough.

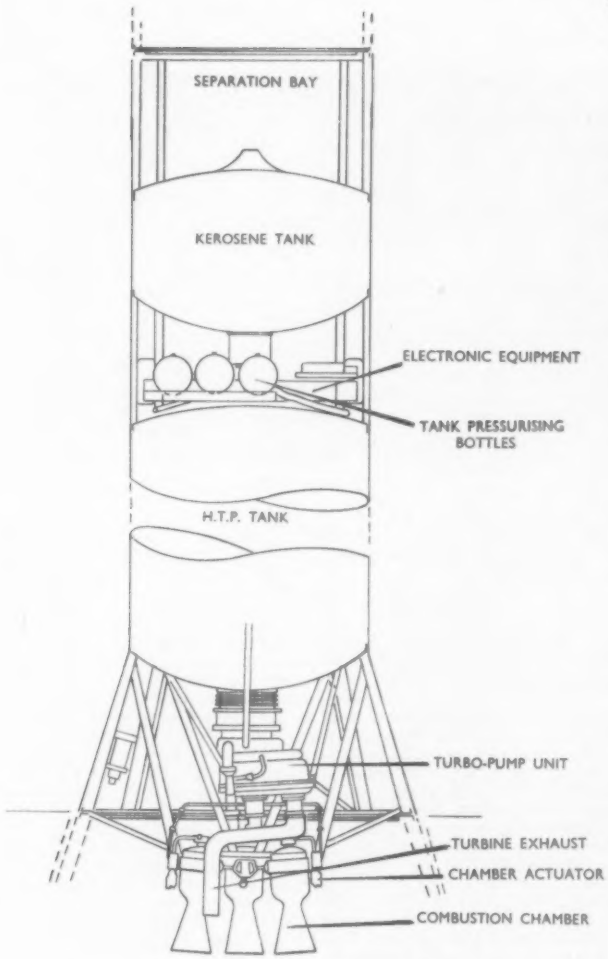


Fig. 2. Layout of second stage.

than in its normal rôle, and there are other problems which would arise because of its rather long, thin shape. These include aerodynamic and control problems, and also an engineering and weight problem in providing a satisfactory junction between Blue Streak and Black Knight because of the great difference in their diameters. The small diameter, 3 ft., of Black Knight could also put a limitation on the maximum dimension of the satellite payload which could conveniently be accommodated.

In our preferred satellite launching vehicle, illustrated in Fig. 1, the second stage is not, therefore, Black Knight as it now is, but a new HTP/kerosene rocket closely derived from it. The tank diameter has been increased from 3 ft. to 4 ft. 6 in. and the propellent capacity has been increased. The overall length is reduced by about 10 ft. It is powered by a Black Knight propulsion unit and, as well as being based on well-established design methods and manufacturing techniques, would use much of the ancillary equipment and other instrumentation—such as the hydraulic system for swivelling the four combustion chambers to steer the rocket—already developed for Black Knight. This stage is illustrated in Fig. 2.

Consideration of the possibility of using the Blue Streak/Black Knight combination, in a suitably modified form, for launching a near-Earth circular orbit satellite raises immediately an important difference between the powered trajectory of a ballistic missile and that of a satellite launching vehicle. At the termination of powered flight—or "cut-off"—of a ballistic missile, the velocity must have been adjusted in magnitude and direction so that the ballistic trajectory from the position of cut-off passes through the target, but the actual height at cut-off, which, for a medium- or long-range ballistic missile, lies between 50 and 100 miles, is not of itself of primary significance. For the satellite launcher the height at cut-off is of importance. If perigee is to be at 300 miles altitude, then the final increment of velocity to achieve the appropriate orbital velocity must be added at, or above, this altitude. The magnitude and direction of the velocity at cut-off then determines the plane of the orbit, the precise altitude of perigee and the orbital eccentricity.

For a Blue Streak/Black Knight combination of the above type, the optimum launching trajectory for any orbit with 300-mile perigee would have to consist of first-stage burning followed by the separation of Blue Streak, and the simultaneous lighting of the Black Knight engine (while still under residual axial thrust during the "die-away" period of the Blue Streak engine). Black Knight would then burn a substantial percentage—perhaps 90%—of its propellent load and then cut its engine and coast from maybe a 100 miles altitude up to the perigee altitude of 300 miles. After this period of coasting it would be necessary to relight the Black Knight engine and burn the remainder of the propellents in order to inject the satellite, and the now empty Black Knight, into orbit.

The long coasting period of many minutes' duration and, in particular, the relighting of the Black Knight engine after it, raises a number of new problems. The precise behaviour of the contents of the Black Knight tanks during the weightless coasting period is unpredictable, but it would almost certainly be necessary to apply some axial acceleration to the vehicle, possibly by small auxiliary solid rockets, in order to restore conditions within the tanks to normal before attempting to relight the engine. In addition, it would be necessary to control the attitude of Black Knight either throughout the coasting period or at least for some time prior to "relight," in order to ensure that the final burst of thrust for orbital injection was properly aligned.

These problems are patently soluble, and a wide variety of schemes for solving them has been examined, but they all introduce additional weight and complication, which, if possible, it would be preferable to avoid. In many of the satellite launchings to date they have been avoided by spin-stabilizing during coasting the final *solid* rocket stage or stages to the attitude required at orbital injection, obtained from a datum carried in an earlier stage. This process tends to lead to rather inaccurate orbits, and the axial rotation needed for stability may well be unacceptable for many satellite applications.

Such considerations as those outlined above have led to the concept of our third-stage rocket—illustrated in Fig. 3—for the 300-mile circular orbit. This is a small, steerable-thrust, four-chamber HTP/kerosene rocket having a very low total thrust of the order of 1,000 lb. The engine would be lit during separation from the second stage and would continue to burn throughout what would otherwise be the coasting period, and would be cut off only when orbital altitude and velocity had been achieved. This approach avoids the problem of engine relight after a period of weightlessness, and eliminates the need for a separate third-stage attitude control system.

Attitude control, either to a previously defined pitch-heading programme or to pitch commands transmitted from the ground, would be accomplished by means of the swivelling thrust chambers. The vertical velocity of the vehicle at second-stage cut-off would be so adjusted that it would coast up to the required orbital altitude, and third-stage thrust (aligned at all times very closely to the local horizontal) would expend all its energy in accelerating the vehicle, and none in doing work against gravity or drag, since at these altitudes the latter will be negligible.

The use of continuous gentle thrusting throughout the

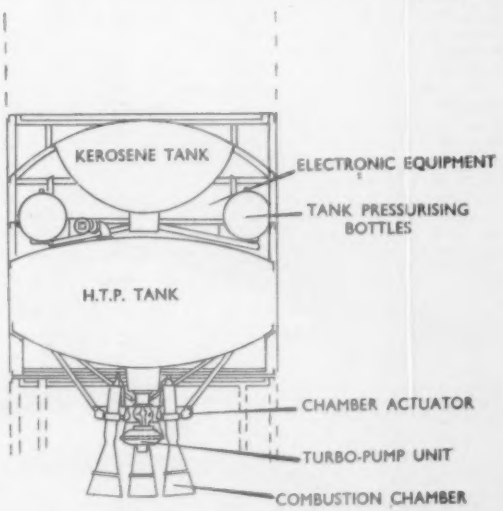


Fig. 3. Layout of third stage employing H_2O_2/kerosene "vernier" rocket engines.

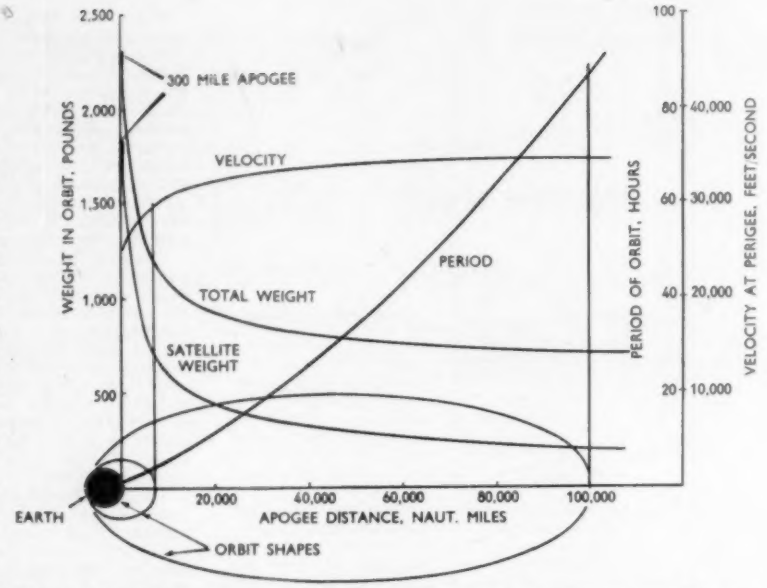


Fig. 4. Satellite launching vehicle performance: 300 n. mile perigee altitude.

"coasting" phase shows considerable performance promise and, incidentally, as will be mentioned later, eases the launching vehicle guidance problems. So far as is known, this technique has not previously been advocated, and certainly not exploited, for satellite launching in the U.S.A. The total weight of the third-stage plus satellite payload is of order 5,000 lb., and it is possible to meet all three of the orbital requirements outlined earlier by exchanging satellite payload for additional propellents in the third stage. This, of course, implies varying the third-stage tank sizes according to the mission, but the remainder of the third stage, including the propulsion unit and all the ancillary equipment, can remain sensibly unchanged. This three-stage combination then well meets the requirement that there should be the maximum degree of "commonness" between the vehicle to meet the three launching requirements.

The estimated performance of the three-stage satellite launching vehicle described is illustrated in Fig. 4. In this figure both total weight in orbit and estimated satellite weight (that is total weight in orbit less the weight of the empty third stage) are plotted against the apogee distance for a series of orbits with perigree at 300-miles altitude. These figures assume that propellent capacity in the third stage is continually adjusted to suit the changing orbital requirements. The performance figures are also based on zero contribution from the Earth's rotational velocity, that is on polar orbits. They could be improved somewhat by firing in a direction having an easterly component, and would be correspondingly reduced by firing westwards.

The curve of satellite weight in Fig. 4, which must be regarded with some reserve at this early design-study stage, indicates the following payload-in-orbit capabilities for the three launching tasks:—

(i) A satellite of order 1,800 lb. weight in a 300-mile altitude circular orbit.

(ii) A satellite of order 600-700 lb. weight in an eccentric orbit with apogee at an altitude of two Earth radii.

(iii) A payload of order 100-200 lb. weight in a highly eccentric orbit with apogee at 100,000 miles.

Fig. 5 illustrates the geometry and timing of a typical three-stage rocket trajectory. The fact that entry into orbit takes place some 17 minutes after launch, and at a distance of order 2,700 miles from the launch point, raises immediately the question of how the vehicle would be guided during its powered flight. Guidance accuracy requirements for scientific space investigations are difficult to pin down. In the early stages of such investigations they are likely to be rather loose, but as experiments proceed they may, perhaps, be expected to tighten up somewhat, but they are likely to remain substantially less stringent than the accuracy requirements for the guidance of a long-range ballistic missile. For a 2,500-mile missile, an accuracy of 1 mile at the target demands an accuracy in cut-off velocity of 3 ft./sec. A "nominal" circular orbit at 300 miles altitude, which oscillates between 290 and 310 miles only, demands an accuracy at cut-off of 70 ft./sec.

It is obviously desirable to evolve a guidance system which does not by its nature limit the ultimate accuracy which can be obtained, and which can be improved as and when the need arises. A variety of schemes have been examined. Essentially the choice lies between radar measurement of position and velocity from the ground with radio-link commands to the vehicle, and an inertial navigation system in the vehicle.

Each has advantages and disadvantages. Because of the great range over which guidance must be exercised, and because of restrictions in radio visibility due to the Earth's horizon, two radar measuring stations would be needed as indicated in Fig. 5. One of these would be located in the neighbourhood of the launch point (and would probably be required in any case as part of the range safety equipment), while the other must be located roughly beneath the point of entry into orbit to permit accurate insertion into orbit. If the forward guidance station is fixed in location there is likely to be a serious limitation on the freedom of choice of launching azimuth, and hence orbital inclination, and some, though probably not serious, limitations on the choice of powered trajectory in the vertical plane to ensure that orbital injection takes place within the coverage of the forward guidance station.

The airborne components of the radar guidance system, which must be carried in the third rocket stage, consist of a beacon to assist ground tracking and a command-link receiver. These can be made satisfactorily small and light in weight. The low thrust of the third stage, and hence the low acceleration of the vehicle as it approaches cut-off, allows the radar guidance information to be smoothed with a rather long time constant, giving a corresponding improvement in the accuracy with which cut-off conditions are defined.

In principle, an inertial guidance system offers complete freedom in choice of launching azimuth, and of trajectory in the vertical plane. However, by comparison with the airborne element of a radio guidance system, an inertial navigator plus its associated computer is likely, in the current state of the art, to be a heavy, complex, and expensive device, which could be an embarrassment in the third rocket stage.

At present radar guidance is favoured, and investigations are being made of a variety of possible ground measuring instruments, including high-power narrow pencil-beam radars, and also interferometer systems with auxiliary range measuring equipment. In the long term the most desirable system might well consist of a lightweight, and perhaps much simplified, inertial system used in conjunction with radar guidance in the neighbourhood of the launching area.

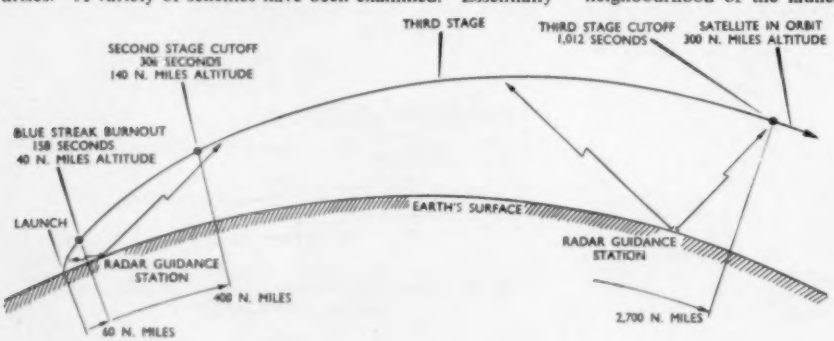


Fig. 5. Typical launch trajectory of vehicle for 300 n. mile altitude circular orbit.

This equipment is in operation at
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Kai Tak, Hong Kong
Rongotai, Wellington, New Zealand
R.R.A.F. Southern Rhodesia.
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STC Precision Approach Radar *type SLA 3B2*

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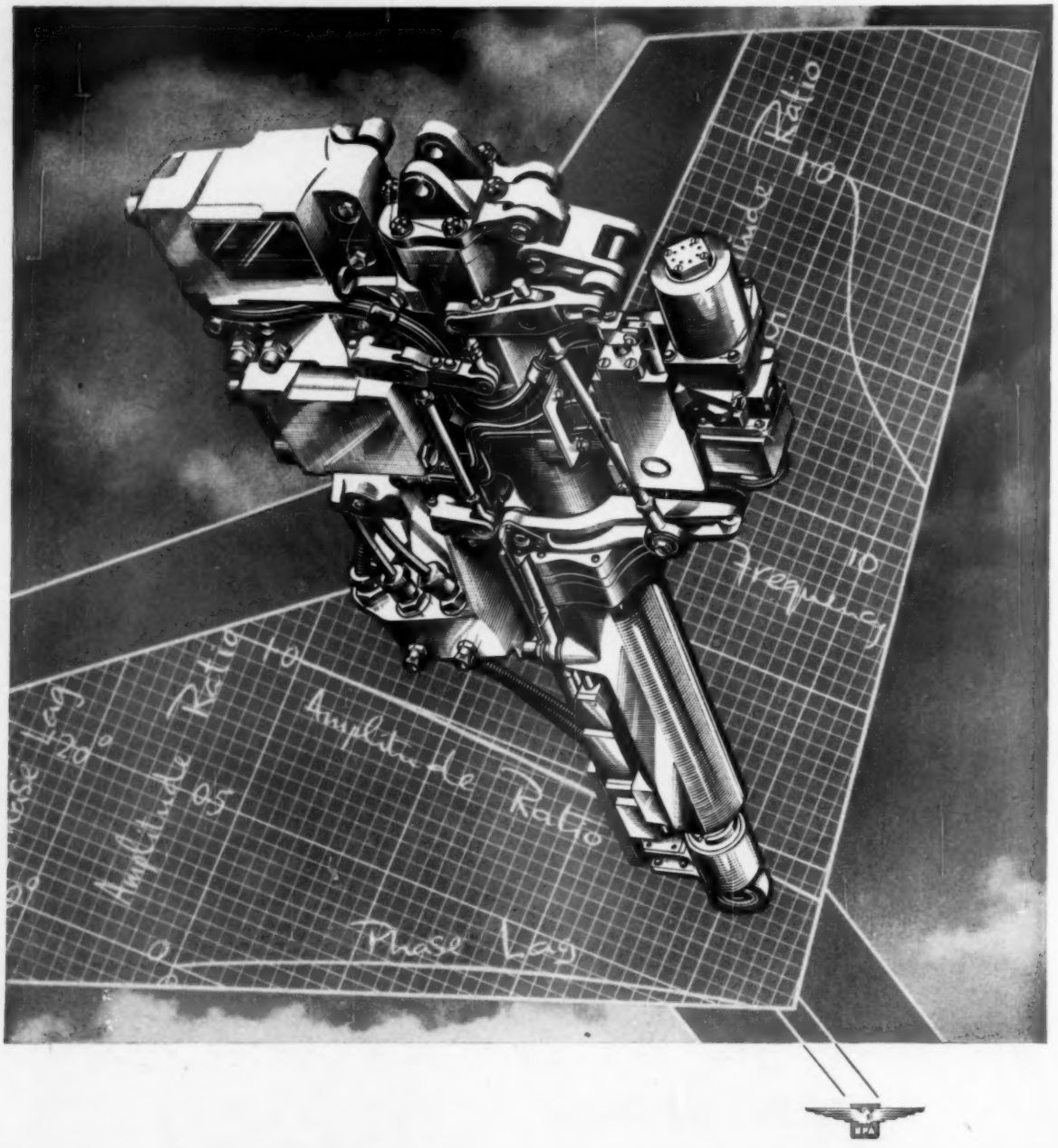

POWER CONTROLS

Boulton Paul powered flying control units incorporate rotary control valves, designed for sensitivity and accurate response. The tandem ram unit illustrated actuates the Blackburn NA.39 all-moving tail plane and operates in manual control, with or without auto-stabilization, or under complete auto-pilot authority.

BOULTON PAUL AIRCRAFT LTD.

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ASTRONAUTIC HARDWARE

THE AEROPLANE
and ASTRONAUTICS

Drawings by René Boirac
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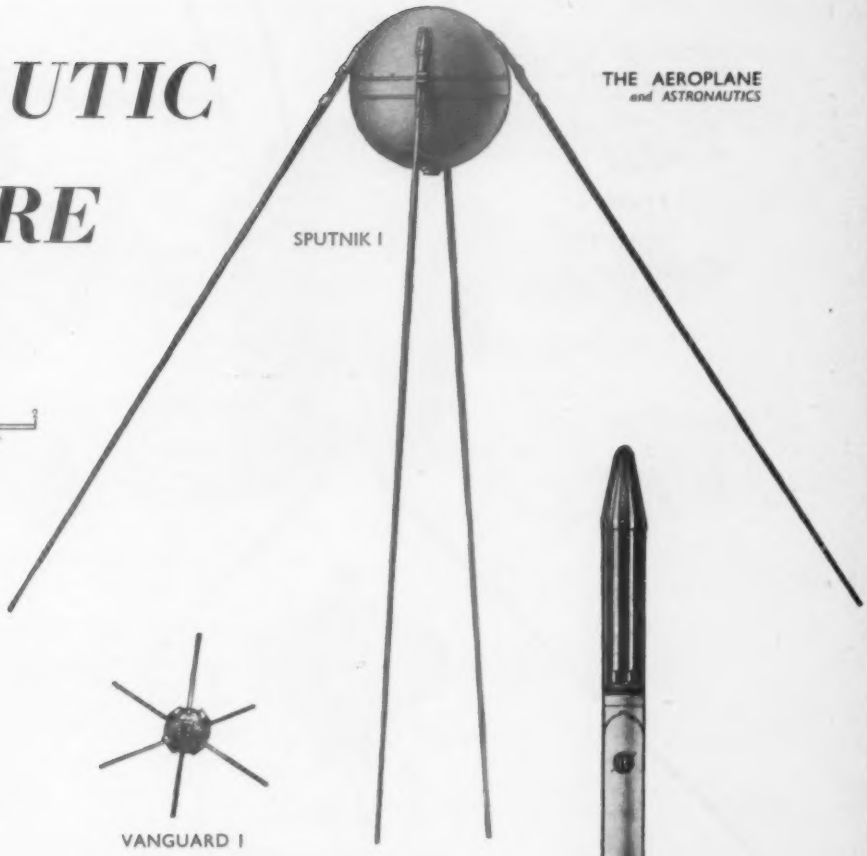
Scale of Feet

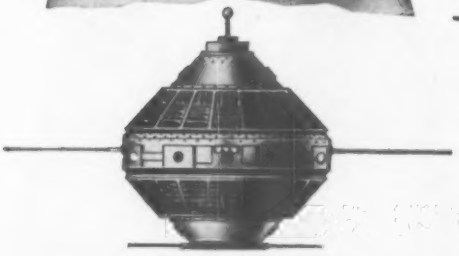


SPUTNIK I

SPUTNIK II

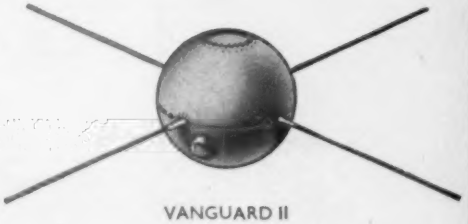
VANGUARD I

EXPLORER III

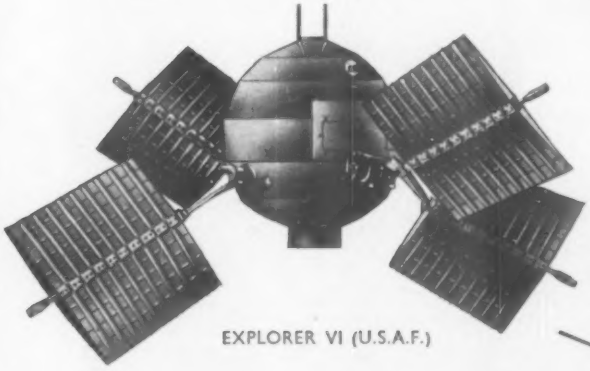


EXPLORER VI (U.S. Army) & VII

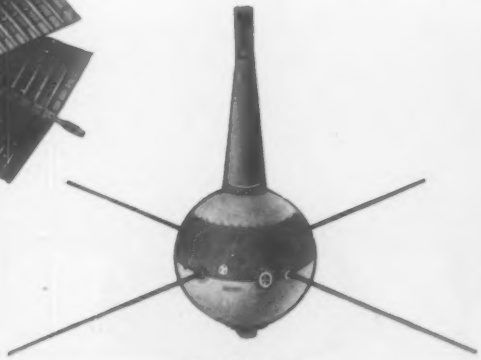
TRANSIT IIA/N.R.L. SATELLITE



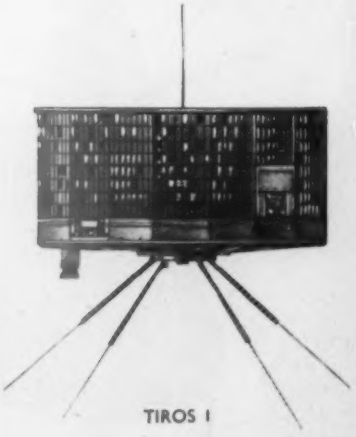
VANGUARD II



EXPLORER VI (U.S.A.F.)



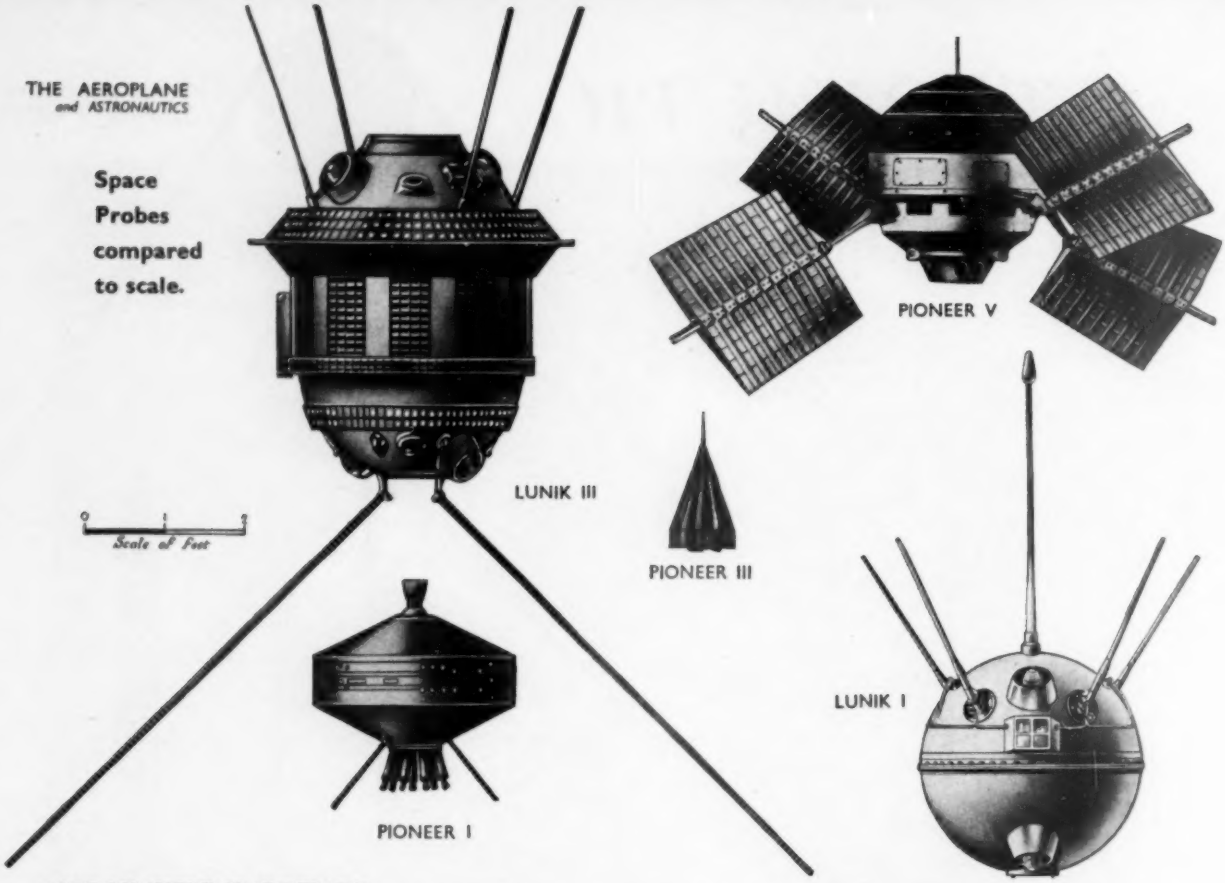
VANGUARD III



TIROS I

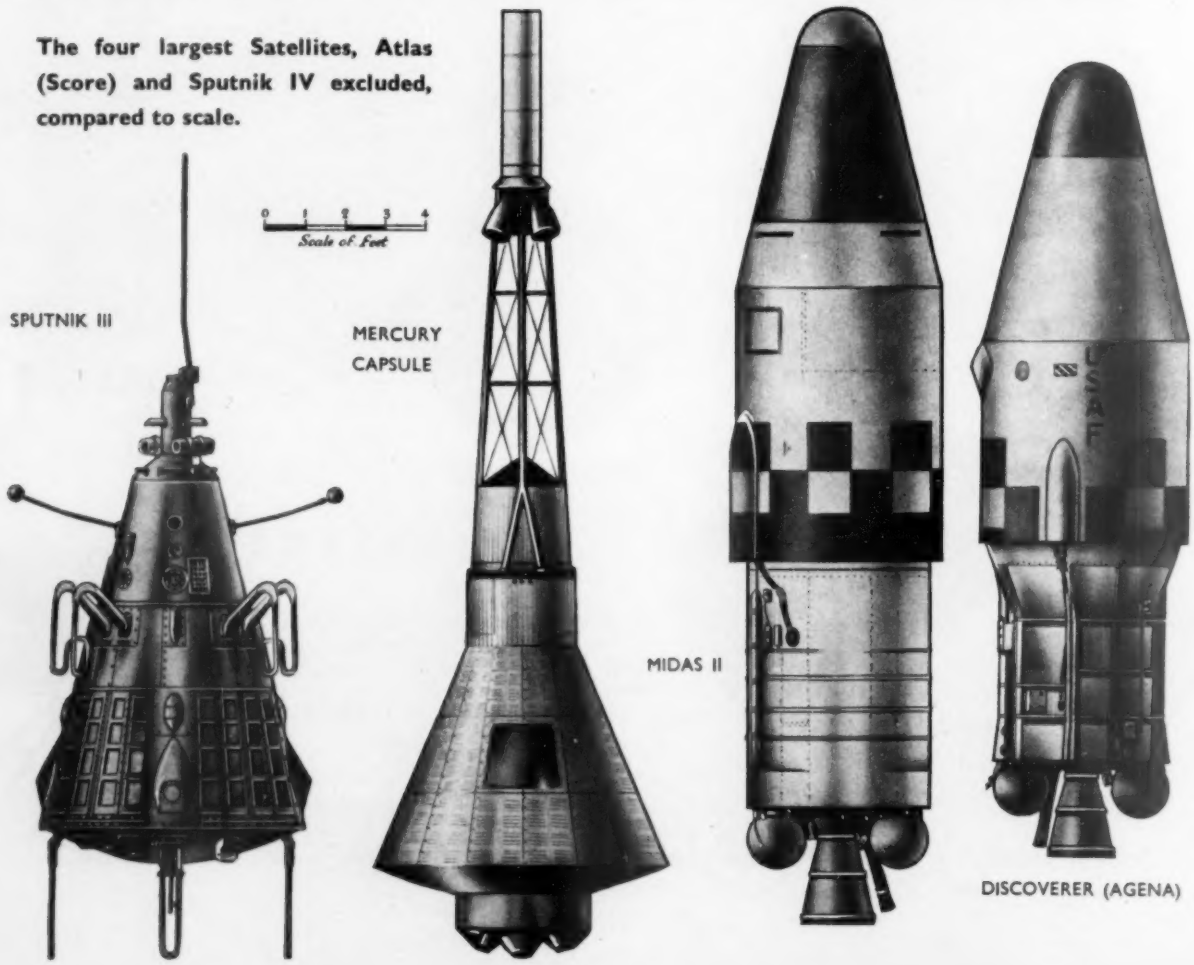
Smaller Satellites compared to scale

Space Probes compared to scale.

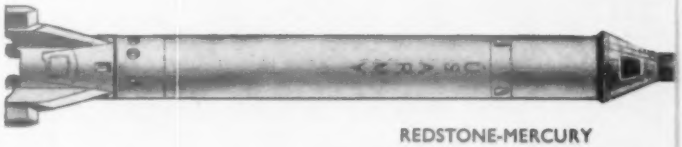


ASTRONAUTIC HARDWARE . . . .

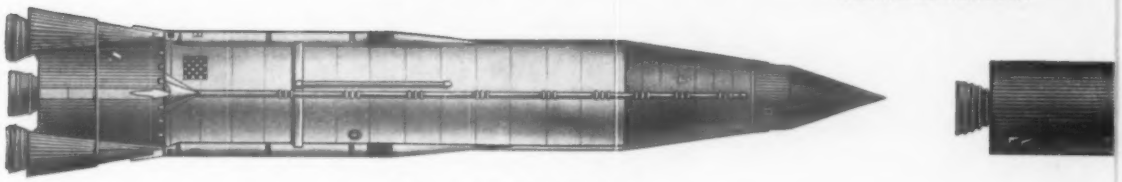
The four largest Satellites, Atlas (Score) and Sputnik IV excluded, compared to scale.



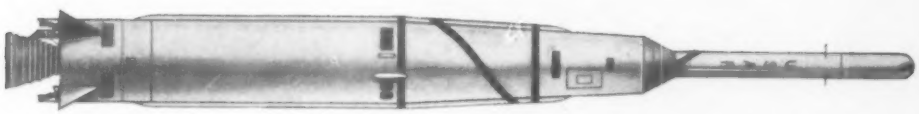
LITTLE JOE-MERCURY



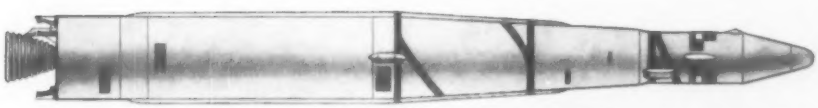
REDSTONE-MERCURY



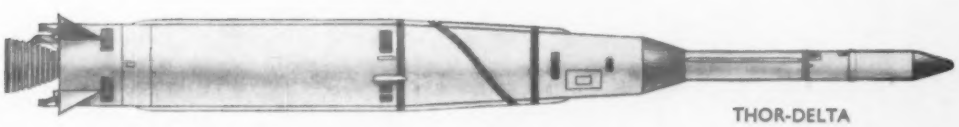
PROJECT SCORE (ATLAS)



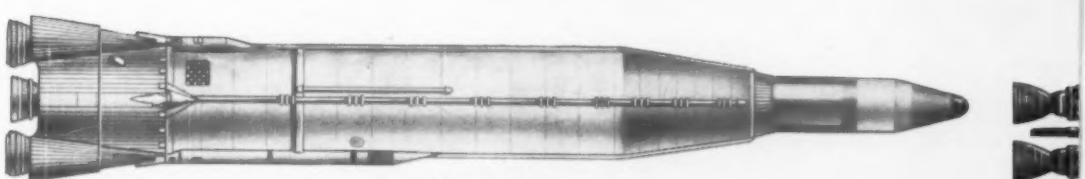
THOR-ABLE



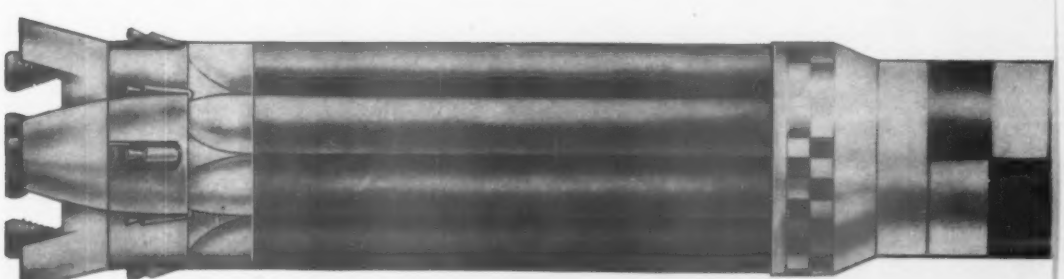
THOR-AGENA A (Discoverer series)

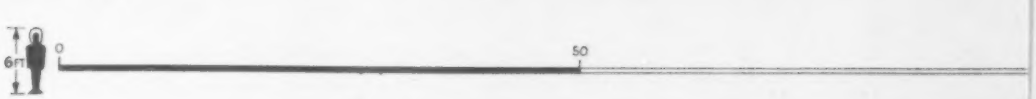


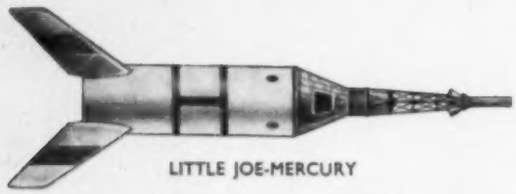
THOR-DELTA



ATLAS-AGENA A





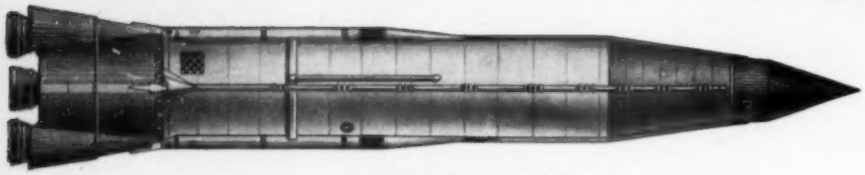


LITTLE JOE-MERCURY

ATLAS-MERCURY

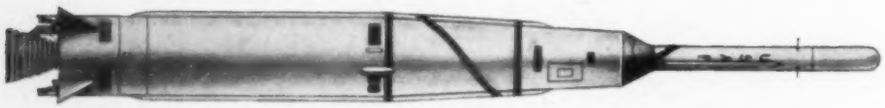
REDSTONE-MERCURY

LUNIK I (Final stage only)

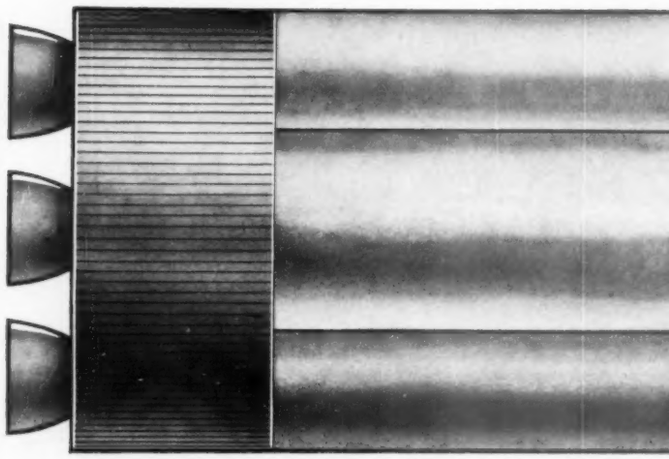


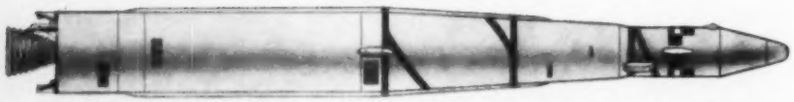
PROJECT SCORE (ATLAS)

JUNO II



THOR-ABLE

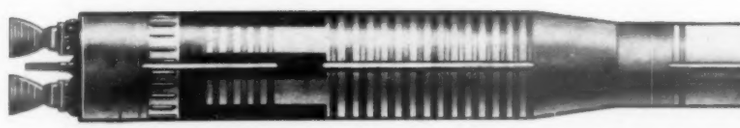




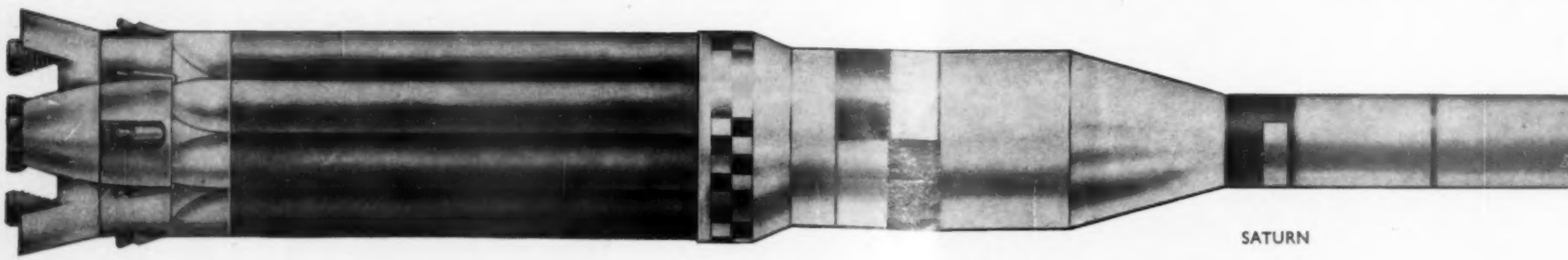
THOR-AGENA A (Discoverer series)

THOR-DELTA

ATLAS-AGENA A



TITAN I.C.B.M. (to be ada



SATURN

PRIME MOVERS OF THE SPACE AGE

BOOSTER SURVEY.—Progress in the field of astronautics continues at a fast pace and already there is promise of important commercial and military applications. On these pages we present a pictorial analysis of all the major space-boosters. On the reverse pages will be found a comprehensive record, with full data, of all the satellites and space probes launched between Aug. 14, 1959, and Jne. 29, 1960. This continues our previous record (THE AEROPLANE AND ASTRONAUTICS, Aug. 28. 1959). Technical data on the space-boosters illustrated are elsewhere in this issue.

Drawings by René Boirac.

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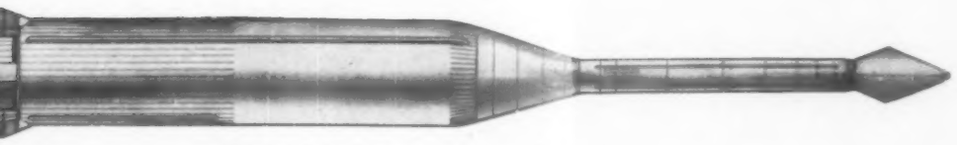
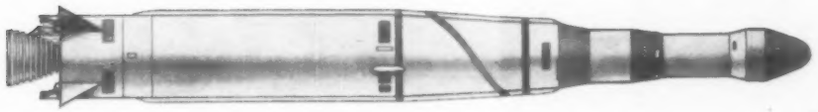
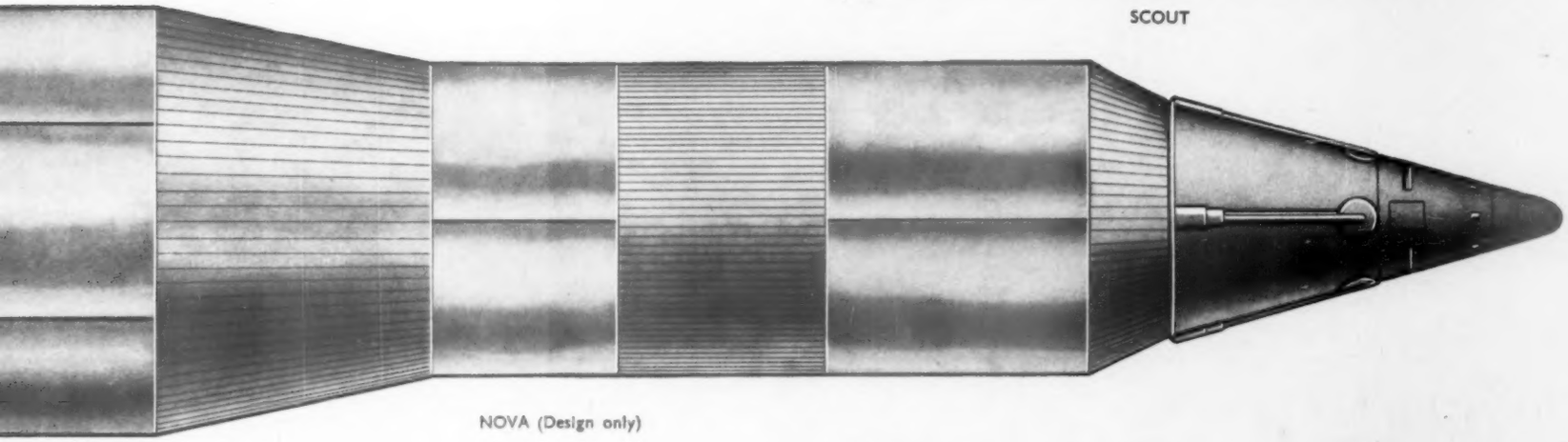


BLUE-STREAK/BLACK KNIGHT (Provisional scheme)



THOR-ABLE STAR

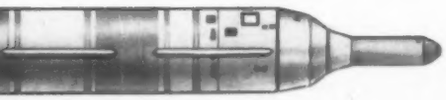
SCOUT



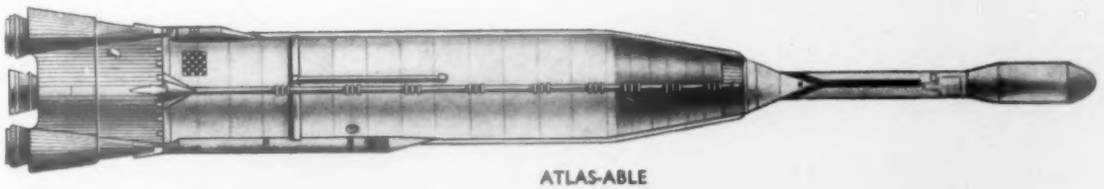
NOVA (Design only)

VANGUARD

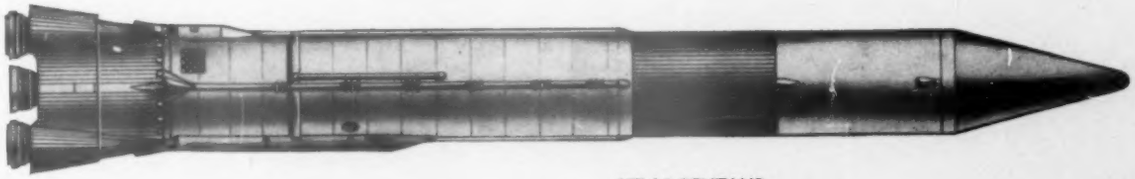
JUPITER C/EXPLORER



o be adapted as Dyna-Soar sub-orbital booster)



ATLAS-ABLE



ATLAS-CENTAUR

Record of all known Space-vehicle Launchings

(Continued from our issue of Aug. 28, 1959, and corrected to Jne. 29, 1960)

Name	Lifetime	Shape and size	Weight	Shell material	Purpose	Radio				Orbit				Launching site and vehicle
						Frequency	Lifetime	Power supply	Antennas	Perigee	Apogee	Period	Inclination to equator	
			lb.			mc.				miles	miles	min.	deg.	
Beacon	Aug. 14, 1959, to 0	(a) Cone-tipped cylinder 31 in. × 7 in. dia. (b) Sphere (inflatable) 12 ft. dia.	84 (total, incl. empty third stage, 25.8 instruments and 10 inflatable sphere)	(a) Stainless steel (b) Mylar plastic film and aluminium foil	Drag studies in upper atmosphere.	108.03 at 50 mw. (transmitter in 3rd stage casing)	(a) } Not (b) } applic.	12 mercury batteries	2 dipole using skin of third stage casing	FAILED TO ORBIT (Fuel depletion in booster and fault in attitude control of upper stages)				†Modified Juno II (AM-19B) 3 stages, launch wt 121,000 lb.
Discoverer VI	Aug. 19, 1959, to Sept. 16, 1959	Cone-tipped cylinder 19 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, incl. empty second stage and 300 re-entry capsule)	Not disclosed	Ejection and recovery of capsule from orbit. (Capsule ejected but not recovered).	Not disclosed	Not applicable	Nickel cadmium batteries	1 directional, 1 whip	139	537	95.0	Polar orbit	‡Thor-Agena A 2 stages, launch wt. 100,000 lb. plus.
Lunik II (Moon-impact probe)	Sept. 12, 1959 (6 a.m. EDT). Time of impact on Moon: 5:02:24 p.m. EDT, Sept. 13, 1959	Sphere 3 ft. 11 in. dia. (instrument container separated from final stage)	858.4 (instrument container) 3,324 (empty final stage)	Two hermetically sealed shells of aluminium-magnesium alloy	Measurement of internal temperature and pressure; magnetic fields of Earth and Moon, meteoritic particles, heavy nuclei in primary cosmic radiation and other properties of cosmic rays.	(a) 183.6 (radio-altimeter in probe); (b) 39.986 (in probe); (c) 19.993 (in probe); (d) 20.003 (in final stage); (e) 19.997 (in final stage)	Duration of mission	Not disclosed	Not disclosed	Travelled 236,875 miles				*Modified Soviet ICBM? (Probably three stages, final stage 20 ft. long × 10 ft. dia. approx.)
Transit I	Sept. 17, 1959, to 0	Sphere, 36 in. dia., ringed by banks of solar cells	265	Two layers of glass fibre with honeycomb structure between	Experimental navigational satellite, emitting signals for Doppler tracking.	(a) 54 (b) 162 (c) 216, all at 100 mw.	Not applicable	2 silver zinc and 2 nickel-cadmium batteries, latter two recharged by solar cells	Wide-band, spiral, slot-type, on outer shell	FAILED TO ORBIT (Third stage did not ignite)				†Thor-Able 3 stages.
Vanguard III (SLV–7)	Sept. 18, 1959 (30 to 40 years est.)	Sphere, 20 in. dia. with 26 in. tapered tube extension; plus empty third stage	50 (about 100 with empty third stage, which remains attached)	Highly polished silicon-monoxide-coated magnesium	Measurement of Earth's magnetic field, solar X-rays, and environmental conditions in space.	(a) 108.00 at 30 mw., (tracking, X-ray, environmental); (b) 108.03 at 80 mw. (magnetometer and command)	Programmed for about 90 days	Silver zinc batteries	4 spring-lock rods	319	2,329	130.0	33.4	†U.S. Navy Vanguard STV–7 (last of series).
Lunik III ("automatic interplanetary station")	Oct. 4, 1959, to April, 1960 (?)	Cylinder with hemispherical end caps, 4 ft. 3 in. × 3 ft. 11 in. dia.	613 (instrument container) 344 (instruments in final stage, total empty wt. 3,416)	Aluminium-magnesium alloy	Photography of far side of Moon from 40,000–45,000 miles. Incorporated 35 mm. film camera having 2 lenses (focal lengths 200 and 500 mm. resp.); auto-film processing equip.; TV-scanner and transmitter; also instruments for measuring radiation in space, Moon's magnetic field, micro-meteorites.	(a) 39.986 (scientific data and parameters of movement); (b) 183.6	Duration of mission	Chemical batteries and solar cells	6 metal rods	29,500	298,000	15 days	—	*Modified Soviet ICBM? (Probably three stages, similar to Lunik I and II vehicles.)
Explorer VII	Oct. 13, 1959 (2 years est.)	Toroid 30 in. × 30 in. dia.	91.5	Plastic-impregnated glass fibre	Seven concurrent experiments, including weather study; measurement of heat radiation of Sun and Earth. Measurement of Lyman-alpha particles and soft X-rays from Sun; also meteoritic particles.	(a) 108.00 (b) 20.00	Will be switched off 1 year after launching	Chemical batteries and solar cells	(a) 4 whip (b) 4 extensible rods	344.5	677.9	101.35	50.3	†U.S. Army Juno II Same as for Explorer VI (U.S. Army).
Discoverer VII	Nov. 7, 1959	Cone-tipped cylinder 19.2 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, including empty second stage and 300 recovery capsule)	Not disclosed	Ejection and recovery of capsule from orbit. Satellite stage failed to stabilize and capsule was not ejected as planned on 17th orbit.	Not disclosed	Not disclosed	Nickel-cadmium batteries	1 directional, 1 whip	104	550	95.0	Polar	‡Thor-Agena 2 stages (same as for Discoverer VI).
Discoverer VIII	Nov. 20, 1959	Cone-tipped cylinder 19.2 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, including empty second stage and 300 recovery capsule)	Not disclosed	Ejection and recovery of capsule from orbit. Satellite entered eccentric orbit and capsule was ejected on 15th orbit instead of 17th. Believed that parachute failed to open.	Not disclosed	Not disclosed	Nickel-cadmium batteries	1 directional, 1 whip	115	1,042	103.72	Polar	‡Thor-Agena 2 stages (same as for Discoverer VII).
Pioneer (Moon probe)	Nov. 26, 1959	Sphere, 42 in. dia. with 4 vane extensions containing 8,800 solar cells	372, including 2 electronic scanner	Not disclosed	Designed to obtain elementary pictures of Moon's surface from approx. 5,000 mile lunar orbit by means of electronic scanner. Also measurement of radiation, magnetic fields, micro-meteorites and activity of "gaseous clouds of plasma floating in space." Carried vernier and retro-rockets.	Not disclosed	Not disclosed	"Paddlewheel" solar cells recharging chemical batteries	Dipole rods (top and bottom)	FAILED IN MISSION (Nose-cap broke up under vibration and second stage did not fire)				†Atlas-Able IV 3 stages, launch wt. 260,000 lb. plus.
Discoverer IX	Feb. 4, 1960, to 0	Cone-tipped cylinder 19.2 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, including empty second stage and 300 recovery capsule)	Not disclosed	Ejection and recovery of capsule from orbit. Capsule contained solid-propellent retro-rocket, parachute, radio beacon, radar chaff and rotating high-frequency stroboscopic light for recovery.	Not disclosed	Not applicable	Nickel-cadmium batteries	1 directional, 1 whip	FAILED TO ORBIT (Damage to second stage due to fault in fuel connection in servicing gantry; caused premature shut-down of first stage)				‡Thor-Agena 2 stages (same as for Discoverer VIII); launch wt. 108,500 lb. approx.
Discoverer X	Feb. 19, 1960, to 0	Cone-tipped cylinder 19.2 ft. × 5 ft. dia.	1,700 (total, including empty second	Not disclosed	Ejection and recovery of capsule from orbit. (Same capsule arrangement as Discoverer IX.)	Not disclosed	Not applicable	Nickel-cadmium batteries	1 directional, 1 whip	FAILED TO ORBIT (Launch vehicle destroyed by Range Safety Officer after 52 sec. after control fault				‡Thor-Agena 2 stages (same as for Discoverer IX).

Discoverer X	Feb. 19, 1960, to 0	Cone-tipped cylinder 19.2 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, including empty second stage and 300 recovery capsule)	Not disclosed	Ejection and recovery of capsule from orbit. (Same capsule arrangement as Discoverer IX.)	Not disclosed	Not applicable	Nickel-cadmium batteries	1 directional, 1 whip	FAILED TO ORBIT (Launch vehicle destroyed by Range Safety Officer after 52 sec. after control fault developed at 20,000 ft.)				‡Thor-Agena 2 stages (same as for Discoverer IX).
Midas I (Missile Defense Alarm System)	Feb. 26, 1960, to 0	Cone-tipped cylinder 22 ft. × 5 ft. dia.	4,500 (total, including empty second stage)	Not disclosed	Experimental detection of missile-launchings with satellite-borne infra-red sensors. (Satellite-stage contained infra-red, telemetry and communications equipment.)	Not disclosed	Not disclosed	Chemical batteries	Not disclosed	FAILED TO ORBIT (Believed that Agena second-stage did not separate from Atlas)				†Atlas-Agena A 2 stages, launch wt. 260,000 lb. approx.
Pioneer V (Solar probe)	Mar. 11, 1960 (In orbit around Sun)	Sphere, 26 in. dia. with 4 square vane extensions containing 4,800 solar cells	94.8 (total, including approx. 40 of instruments)	Not disclosed	Various "solar" experiments. Probe contains high-energy radiation counter, ionization chamber and Geiger-Muller tube for measurement of plasmas, cosmic radiation and charged solar particles. Also magnetometer, micrometeorite impact counter, aspect indicator, temp. sensors.	378 at 5 watt for initial data readout; at 150 watt for long range	Transmission terminated, or probe passed out of range with 5w. transmitter at 22.5 million miles (Jne. 26, 1960). 150w. transmitter out of action earlier, due to battery deterioration	"Paddlewheel" solar cells recharging 28 nickel-cadmium batteries	Not disclosed	74.9 million (perihelion)	92.3 million (aphelion)	311.6 days	3.35 to Ecliptic	†Thor-Able IV 3 stages, launch wt. 105,000 lb. approx.
										SUN SATELLITE				
Explorer VIII	Mar. 23, 1960, to 0	Cone-tipped cylinder 21 in. long surrounded by 9 × 12 in. solar-cell array	35.3 (total, including 12.5 empty fourth stage and 22.8 instruments)	Aluminium	Investigation of radiation belts in orbit inclined at 28° with 200-mile perigee and 33,000-mile apogee. Satellite carried 5 radiation experiments for detection and counting of electrons and protons. Temperature sensors also fitted.	108.03 at 300 mw. (data transmission simultaneous on 5 channels)	Not applicable	1,184 solar-cells recharging nickel-cadmium batteries	Not disclosed	FAILED TO ORBIT (Ground stations lost contact after burnout of second stage; presumed third and fourth stages did not fire)				†Juno II 4 stages, launch wt. 120,000 lb.
Tiros I (Television, Infra-red Observation Satellite)	Apr. 1, 1960 (50 to 100 years est.)	Cylinder 19 in. long × 42 in. dia. covered on top and sides by 9,200 solar cells	270	Aluminium and stainless steel	Experimental weather satellite; cloud photography over wide areas of Earth. Contains 1 wide and 1 narrow angle TV camera, each with tape recorder for remote operation. Photo data interrogation ceased on Jne. 17, 1960, after over 22,000 pictures obtained.	(a) 235 at 2 w. (two picture-information transmitters); (b) 108 and 108.03 at 30 mw. (tracking)	Indefinite (tracking transmitters)	Solar-cells recharging nickel-cadmium batteries	4 dipole (transmission), 1 dipole (receiving)	429.7	467.4	99.2	48.3	†Thor-Able 3 stages, launch wt. 150,000 lb. approx.
Transit IB	Apr. 13, 1960 (16 months est.)	Sphere 36 in. dia., ringed by banks of solar cells	265	Glass fibre	Experimental navigational satellite. Contained 2 ultra stable oscillators in temp. resistant Dewar flasks. Infra-red scanner to measure rotation. Two receivers; two telemetering receivers and transmitters.	(a) 54 (b) 162 (c) 216 (d) 324	1 month for chemical batteries	Solar-cells recharging nickel-cadmium batteries	Wide-band, spiral, slot-type, on outer shell	233	479	96.0	51.0	†Thor-Able Star 2 stages, launch wt. 150,000 lb. plus.
Discoverer XI	Apr. 15, 1960, to Apr. 26, 1960	Cone-tipped cylinder 19.2 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, including empty second stage, 300 recovery capsule and 10 inst. package in Agena for tracking exp. in conj. with Transit programme)	Not disclosed	Ejection and recovery of capsule from orbit. (Same capsule arrangement as Discoverer X.) Capsule ejected but not observed.	Not disclosed	Not disclosed	Chemical batteries	1 directional, 1 whip	109	380	92.25	80.1	‡Thor-Agena 2 stages, launch wt. 108,500 lb. (same as for Discoverer X).
Echo	May 13, 1960, to 0	Sphere, 26.5 in. dia. (package); 100 ft. (inflated satellite)	132 (total, including 4 aluminium covering; 30 sublimating powder; 24 magnesium packaging; 50 third-stage casing	Mylar polyester covered with aluminium, vapour-deposited	Passive reflector for radio-communication experiments. (Aluminium coating provides 98% reflectivity of radio waves up to 20,000 mc.) Primary ground stations at Holmdel, N.J., and Goldstone, Cal.	108.06 at 60 mw. (in third stage)	Continuous 6 to 10 days	Mercury batteries (in third stage)	Not disclosed	FAILED TO ORBIT (Fault in attitude control of second stage and failure of third stage to receive ignition signal from ground station)				†Thor-Delta 3 stages, launch wt. 112,000 lb.
Sputnik IV ("spaceship-satellite")	May 15, 1960 (few months est.)	Two-part vehicle, including detachable pressurized cabin. Configuration not disclosed	10,008 (total, including 5,512 pressure cabin; 3,250 instruments)	Not disclosed	Establish pressure cabin in near-circular orbit, test of life-support systems for manned spaceflight, ejection of cabin from orbit by retro-rocket. Cabin contained "dummy" astronaut and environmental control system.	19.995 (telemetry and telephone)	Indefinite	Chemical and solar batteries	Not disclosed	188.5 191*	191 429*	91.1 94.25*	64.9	σMulti-stage booster (same type as test-fired into Central Pacific in January, 1960). Last stage injection velocity, 17,300 m.p.h.
										*Orbital elements after firing of retro-rocket at wrong angle on May 19, 1960				
Midas II	May 24, 1960 (40 months est.)	Cone-tipped cylinder 22 ft. × 5 ft. dia.	5,000 (approx. total, including empty second stage)	Not disclosed	Experimental detection of missile-launchings with satellite-borne infra-red sensors. (Equipment similar to Midas I.)	Not disclosed	Not disclosed	Chemical batteries	Not disclosed	292.1	322	94.3	33.0	†Atlas-Agena A 2 stages (same as for Midas I). Injection velocity 17,045 m.p.h.
Transit IIA	Jne. 22, 1960 (50 years est.)	Sphere 36 in. dia., ringed by banks of solar cells	223	Glass fibre	Experimental navigational satellite. Similar to Transit IB but with electronic clock as time standard; also carries Canadian receiver to measure "galactic noise." Ground stations also making geodetic measurements.	(a) 54 (b) 162 (c) 216 (d) 324	Up to 1 year	Solar cells recharging nickel-cadmium batteries	Wide-band, spiral, slot-type, on outer shell	460	563	101.5	65.0	†Thor-Able Star 2 stages.
NRL Satellite (launched with Transit IIA as "double-satellite")	Jne. 22, 1960 (50 years est.)	Sphere 20 in. dia., (with six solar-cell panels)	42	Not disclosed	Measurement of solar radiation (Lyman-alpha and X-rays).	108.0	Up to 1 year	Solar cells recharging nickel-cadmium batteries	4 × 25 in. whip-type	460	563	101.5	65.0	†Same vehicle as Transit IIA.
Discoverer XII	Jne. 29, 1960, to 0	Cone-tipped cylinder 19.2 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, including empty second stage, 300 recovery capsule, etc.)	Not disclosed	Ejection and recovery of capsule from orbit. (Same capsule arrangement as Discoverer XI but with additional instrumentation for checking function of orientation system and capsule ejection.)	Not disclosed	Not disclosed	Chemical batteries	1 directional, 1 whip	FAILED TO ORBIT (Did not achieve orbital velocity; re-entered atmosphere and burned up over South Pacific Ocean)				‡Thor-Agena 2 stages, launch wt. 108,500 lb. (same as for Discoverer XI).

Launching site symbols: * Believed to be Kapustin Yar, near Stalingrad; † Cape Canaveral, Florida; ‡ Vandenberg A.F.B., California; σ believed to be Aralsk, near Aral Sea.

Record of all known Space-vehicle Launchings

(Continued from our issue of Aug. 28, 1959, and corrected to Jne. 29, 1960)

Name	Lifetime	Shape and size	Weight	Shell material	Purpose	Radio				Orbit				Launching site and vehicle
						Frequency	Lifetime	Power supply	Antennas	Perigee	Apogee	Period	Inclination to equator	
			lb.			mc.				miles	miles	min.	deg.	
Beacon	Aug. 14, 1959, to 0	(a) Cone-tipped cylinder 31 in. × 7 in. dia. (b) Sphere (inflatable) 12 ft. dia.	84 (total, incl. empty third stage, 25.8 instruments and 10 inflatable sphere)	(a) Stainless steel (b) Mylar plastic film and aluminium foil	Drag studies in upper atmosphere.	108.03 at 50 mw. (transmitter in 3rd stage casing)	(a) } Not (b) } applic.	12 mercury batteries	2 dipole using skin of third stage casing	FAILED TO ORBIT (Fuel depletion in booster and fault in attitude control of upper stages)				†Modified Juno II (AM–19B) 3 stages, launch wt 121,000 lb.
Discoverer VI	Aug. 19, 1959, to Sept. 16, 1959	Cone-tipped cylinder 19 ft. × 5 ft. dia. Capsule 27 in. × 33 in. dia.	1,700 (total, incl. empty second stage and 300 re-entry capsule)	Not disclosed	Ejection and recovery of capsule from orbit. (Capsule ejected but not recovered).	Not disclosed	Not applicable	Nickel cadmium batteries	1 directional, 1 whip	139	537	95.0	Polar orbit	‡Thor-Agena A 2 stages, launch wt. 100,000 lb. plus.
Lunik II (Moon-impact probe)	Sept. 12, 1959 (6 a.m. EDT). Time of impact on Moon: 5:02:24 p.m. EDT, Sept. 13, 1959	Sphere 3 ft. 11 in. dia. (instrument container separated from final stage)	858.4 (instrument container) 3,324 (empty final stage)	Two hermetically sealed shells of aluminium-magnesium alloy	Measurement of internal temperature and pressure; magnetic fields of Earth and Moon, meteoritic particles, heavy nuclei in primary cosmic radiation and other properties of cosmic rays.	(a) 183.6 (radio-altimeter in probe); (b) 39.986 (in probe); (c) 19.993 (in probe); (d) 20.003 (in final stage); (e) 19.997 (in final stage)	Duration of mission	Not disclosed	Not disclosed	Travelled 236,875 miles				*Modified Soviet ICBM? (Probably three stages, final stage 20 ft. long × 10 ft. dia. approx.)
Transit I	Sept. 17, 1959, to 0	Sphere, 36 in. dia., ringed by banks of solar cells	265	Two layers of glass fibre with honeycomb structure between	Experimental navigational satellite, emitting signals for Doppler tracking.	(a) 54 (b) 162 (c) 216, all at 100 mw.	Not applicable	2 silver zinc and 2 nickel-cadmium batteries, latter two recharged by solar cells	Wide-band, spiral, slot-type, on outer shell	FAILED TO ORBIT (Third stage did not ignite)				†Thor-Able 3 stages.
Vanguard III (SLV–7)	Sept. 18, 1959 (30 to 40 years est.)	Sphere, 20 in. dia. with 26 in. tapered tube extension; plus empty third stage	50 (about 100 with empty third stage, which remains attached)	Highly polished silicon-monoxide-coated magnesium	Measurement of Earth's magnetic field, solar X-rays, and environmental conditions in space.	(a) 108.00 at 30 mw., (tracking, X-ray, environmental); (b) 108.03 at 80 mw. (magnetometer and command)	Programmed for about 90 days	Silver zinc batteries	4 spring-lock rods	319	2,329	130.0	33.4	†U.S. Navy Vanguard STV–7 (last of series).
Lunik III ("automatic interplanetary station")	Oct. 4, 1959, to April, 1960 (?)	Cylinder with hemispherical end caps, 4 ft. 3 in. × 3 ft. 11 in. dia.	613 (instrument container) 344 (instruments in final stage, total empty wt. 3,416)	Aluminium-magnesium alloy	Photography of far side of Moon from 40,000–45,000 miles. Incorporated 35 mm. film camera having 2 lenses (focal lengths 200 and 500 mm. resp.); auto-film processing equip.; TV-scanner and transmitter; also instruments for measuring radiation in space, Moon's magnetic field, micro-meteorites.	(a) 39.986 (scientific data and parameters of movement); (b) 183.6	Duration of mission	Chemical batteries and solar cells	6 metal rods	29,500	298,000	15 days	—	*Modified Soviet ICBM? (Probably three stages, similar to Lunik I and II vehicles.)

Table of Rocket Boosters

Name	Prime Contractor	Propulsion		Vehicle Characteristics				Remarks
		Powerplant	Propellent	Length	Diameter (max.)	Launching weight	Payload performance	
ATLAS–ABLE	STL, Convair	Stage 1: 1×60,000 lb. s.t. Rocketdyne LR–105 (L.P.) +2×160,000 lb. s.t. Rocketdyne LR–93 (L.P.) jettisonable in skirt. Stage 2: 1×7,700 lb. s.t. Aerojet-General (L.P.). Stage 3: 1×2,300 lb. s.t. ABL×248 (S.P.).	Stage 1: LO_2/RP–1. Stage 2: WFNA/UDMH. Stage 3: Solid.	ft. in. 99 4	ft. in. 10 0 (Atlas body) 16 0 (over booster fairings)	lb. 255,000	2,000 lb. in 300 mile orbit; 372 lb. in 5,000 mile lunar orbit.	First employed to launch 372 lb. Pioneer Moon-probe, unsuccessfully, on November 26, 1959.
ATLAS–AGENA A	Lockheed	Stage 1: 1×60,000 lb. s.t. Rocketdyne LR–105 (L.P.) +2×160,000 lb. s.t. Rocketdyne LR–93 (L.P.) jettisonable in skirt. Stage 2: 1×15,000 lb. s.t. Bell Hustler (L.P.). Stage 3: 1×JPL (L.P.).	Stage 1: LO_2/RP–1. Stage 2: RFNA/UDMH. Stage 3: Storable.	88 2	10 0 (Atlas body) 16 0 (over booster fairings)	265,000 (approx.) (Midas)	3,600 lb. in 300 mile orbit	Atlas–Agena B (overall length 99 ft., second stage 25 ft.×5 ft. dia., 15,000 lb. s.t.) to orbit vehicle of more than 5,000 lb. at 300 miles. Scheduled to launch 800 lb. Ranger Moon-probe.
ATLAS–CENTAUR	Convair	Stage 1: 1×60,000 lb. s.t. Rocketdyne LR–105 (L.P.) +2×160,000 lb. Rocketdyne LR–93 (L.P.) jettisonable in skirt. Stage 2: 2×15,000–20,000 lb. s.t. Pratt & Whitney LR–115 (L.P.). Stage 3: 1×6,000 lb. s.t. J.P.L. (L.P.).	Stage 1: LO_2/RP–1. Stage 2: LO_2/LH_2. Stage 3: Storable.	107 8	10 0 (Atlas body) 16 0 (over booster fairings)	291,000	7,400 lb. in 300 mile orbit; 1,300 lb. in 23,000 mile "stationary" orbit; 730 lb. lunar landing.	First launching scheduled summer, 1961. May launch Ranger-type probes to Mars and Venus.
ATLAS–MERCURY	Convair; McDonnell (capsule).	Series D Atlas 1×60,000 lb. s.t. Rocketdyne LR–105 (L.P.) +2×160,000 lb. Rocketdyne LR–93 (L.P.) jettisonable in skirt.	LO_2/RP–1.	94 6	10 0 (Atlas body) 16 0 (over booster fairings)	250,000 (approx.)	2,000 lb. approx. in 120 mile circular orbit.	Launching vehicle for McDonnell Mercury space-capsule; initial sub-orbital tests and subsequent orbital missions.
ATLAS (Project Score)	Convair	1×60,000 lb. s.t. Rocketdyne LR–105 (L.P.)+2×160,000 lb. Rocketdyne LR–93 (L.P.) jettisonable in skirt.	LO_2/RP–1.	85 0	10 0 (Atlas body) 16 0 (over booster fairings)	244,000	Entire Atlas main stage into close orbit, with 122 lb. payload. (Total wt. in orbit was about 8,660 lb.)	Atlas 10–B (WS107A–1). Single launching only, Dec. 18, 1958; carried radio transmitting, recording and receiving equipment for relaying messages from ground stations in Texas, Arizona and Georgia.
BLUE STREAK/ BLACK KNIGHT. (Schemes only.)	de Havilland Propellers; Saunders-Roe.	Stage 1: 2×125,000 lb. s.t. Rolls-Royce (L.P.). Stage 2: 4×4,100 lb. s.t. Bristol Siddeley Gamma (L.P.).	Stage 1: LO_2/kerosene. Stage 2: HTP/kerosene.	100 0 (approx.)	10 0 (Blue Streak body)	200,000 (approx.)	1,000–2,000 lb. in 300 mile orbit.	Schemes only (de Havilland Propellers); others by R.A.E., Farnborough (see page 186).
JUNO I	ABMA/Chrysler	Stage 1: 1×83,000 lb. s.t. Rocketdyne A–7 (L.P.) Stage 2: 11×scaled-down Sergeants (S.P.) Stage 3: 3×scaled-down Sergeants (S.P.) Stage 4: 1×scaled-down Sergeant (S.P.)	Stage 1: LO_2/"Hydyne" Stages 2, 3 and 4, solid.	68 6	5 10	65,000	30 lb. in 300 mile orbit.	First successful U.S. launching vehicle (also known as Jupiter-C/Explorer). Launched Explorer I, Jan. 31, 1958.
JUNO II	ABMA/Chrysler	Stage 1: 1×150,000 lb. s.t. Rocketdyne S–3D (L.P.). Stage 2: 11×scaled-down Sergeants. Stage 3: 3×scaled-down Sergeants. Stage 4: 1×scaled-down Sergeant.	Stage 1: LO_2/RP–1; all other stages solid.	76 0	8 9	120,000	100 lb. in 300 mile orbit	Launching vehicle for Pioneer IV and Explorer VIII; also three-stage version.
LITTLE JOE–MERCURY	North American Aviation	4×55,000 lb. s.t. Thiokol Castor (improved Sergeants) and 4×33,000 lb. s.t. Thiokol Recruits. (Staggered ignition 2 Castor, 4 Recruits, 2 Castor.)	All solid.	55 0	6 6	40,000 (approx.)	Short-range recovery test of Mercury capsule.	Six test-vehicles to test parachute deployment of Mercury capsule and study bio-medical problems of acceleration and water impact. Instruments and primates only.

Rocket Boosters (continued)

Name	Prime Contractor	Propulsion		Vehicle Characteristics				Remarks
		Powerplant	Propellent	Length	Diameter (max.)	Launching weight	Payload performance	
NOVA .. .. .. (Schemes only.)	NASA	Stage 1: 6×1,500,000 lb. s.t. Rocketdyne F.1 (L.P.). Stage 2: 1×1,500,000 lb. s.t. Rocketdyne F.1 (L.P.). (Possibly up to three further stages.)	Stage 1: LO_2/RP-1. Stage 2: LO_2/RP-1. (Upper stages probably LO_2-LH_2.)	ft. in. —	ft. in. —	lb. —	Soft-land manned vehicle on Moon and return 10,000 lb. re-entry capsule to Earth. Orbit 150,000 lb. "space-laboratory" at 300 miles.	Schemes only. A chemical-nuclear Super Nova vehicle for manned lunar missions in early 1970s has also been proposed. Propellent flow rate of a single F.1 engine will be nearly 6,000 lb./sec.; chamber pressure exceeds 900 lb./sq. in.
PROJECT 3059	Not announced	Solid-propellent engine in 1 to 2 million lb. s.t. class.	Butadiene composite (?)	N.A.	N.A.	N.A.	N.A.	Feasibility studies. Rocketdyne version would be 66 ft.×15 ft. dia., containing 360 tons propellent.
REDSTONE-MERCURY..	Marshall Spaceflight Center.	1×78,000 lb. s.t. Rocketdyne A-7 (L.P.).	LO_2/RP-1.	75 0	—	60,000 (approx.)	Sub-orbital test of Mercury capsule.	Eight vehicles modified from U.S. Army Chrysler M5(SSM-A-14) Redstone.
SATURN C-1	NASA's Marshall Spaceflight Center (S-1 first stage); Douglas (S-4 second stage); Convair (S-5 third stage).	Stage 1: 8×188,000 lb. s.t. Rocketdyne H.1 (L.P.). Stage 2: 4×20,000 lb. s.t. Pratt & Whitney LR-115 (L.P.). Stage 3: 2×20,000 lb. s.t. Pratt & Whitney LR-115 (L.P.).	Stage 1: LO_2/JP-4. Stage 2: LO_2/LH_2. Stage 3: LO_2/LH_2.	185 0	21 6	1,160,000 (approx.)	25,000 lb. approx. in 300 mile orbit; 4,500 lb. in 22,300 mile (24-hr.) orbit; 12,000 lb. in orbit around Moon; 2,000 lb. soft-landed on Moon.	Launching vehicle for Dyna-Soar orbital boost-glider. Later possibly manned space-stations and minimal manned lunar missions. First stage propellent capacity, 750,000 lb.; stage is 82 ft. long. Four inner engines fixed at 3° inclination; outer four inclined at 6° on gimbal mountings with ±7° freedom.
SATURN C-2	NASA's Marshall Spaceflight Center.	Stage 1: 8×188,000 lb. s.t. Rocketdyne H.1 (L.P.). Stage 2: 4×200,000 lb. s.t. Rocketdyne J-2 (L.P.). Stage 3: 4×20,000 lb. s.t. Pratt & Whitney LR-115 (L.P.), or 1×200,000 lb. s.t. Rocketdyne J-2 (L.P.).	Stage 1: LO_2/JP-4. Stage 2: LO_2/LH_2. Stage 3: LO_2/LH_2.	200 0 (4 stage version)	21 6	N.A.	Three-stage C-2 will approx. double each of C-1 payloads; with fourth stage added, could triple 24-hr. orbit and lunar soft-landing capability.	Saturn C-3 may have new third stage (2×200,000 lb. s.t.) inserted between stages 2 and 3 of C-2 version; overall height, 4 stages, 230 ft. Also possibility of nuclear third stage in later version (to soft-land 14,000 lb. on Moon).
SCOUT	Chance-Vought	Stage 1: 1×105,000 lb. s.t. Aerojet-General Algol (S.P.). Stage 2: 1×55,000 lb. s.t. Thiokol Castor (S.P.). Stage 3: 1×15,000 lb. s.t. ABL×—254 Antares (S.P.). Stage 4: 1×3,100 lb. s.t. ABL×—248 Altair (S.P.).	Stage 1: polyurethane composite. Stage 2: polysulphide composite. Stage 3: double-base. Stage 4: double-base.	72 0	3 4	36,100	200 lb. in 300 mile orbit; 50 lb. to an altitude of 12,000 n. miles.	Low-cost launching vehicle. Will launch first U.K.-developed satellite instruments under NASA international programme, beginning 1961. Variants being produced for U.S.A.F. under Hyper-Environmental Test System 609A (Aeronutronic Div., Ford Motor Co.), some with auto-stabilized, enlarged, top stage. Type 1234BG to launch 500 lb. aerodynamic and structural test models of Dyna-Soar boost-glider.
SPUTNIK BOOSTER ..	N.A.	Stage 1: 2×220,000 lb. s.t. R-14 (L.P.). Stage 2: 1×268,000 lb. s.t. R-14a (L.P.). Stage 3: 1×78,000 lb. s.t. R-10 (L.P.).	LO_2/kerosene (?).	N.A.	N.A.	N.A.	N.A.	Modified ICBM, believed to have launched early Soviet Sputniks (data provisional). Multi-stage rockets of 800,000-1,000,000 lb. s.t. probably now developed (e.g., for orbiting Sputnik IV, wt. 10,008 lb.).
THOR-ABLE	STL	Stage 1: 1×150,000 lb. s.t. Rocketdyne MB-3 (L.P.). Stage 2: 1×7,700 lb. s.t. Stage 3: 1×3,100 lb. s.t. ABL×248 (S.P.).	Stage 1: LO_2/RP-1. Stage 2: RFNA/UDMH. Stage 3: double-based solid.	90 0	8 0	105,000 (Pioneer V)	200 lb. in 300 mile orbit	Launching vehicle for Pioneer V and Tiros I.
THOR-ABLE STAR ..	Aerojet-General ..	Stage 1: 1×150,000 lb. s.t. Rocketdyne MB-3 (L.P.). Stage 2: 1×8,000 lb. s.t. Aerojet-General.	Stage 1: LO_2/RP-1. Stage 2: RFNA/UDMH.	79 0	8 0	105,000 plus (Transit 1B and All)	500 lb. at 300 to 500 miles.	Launching vehicle for Transit and Courier satellites. Engine restartable in space (first demonstrated during launching of Transit 1B navigational satellite on Apr. 13, 1960).
THOR-AGENA A ..	Lockheed	Stage 1: 1×150,000 lb. s.t. Rocketdyne MB-3 (L.P.). Stage 2: 1×15,000 lb. s.t. Bell Hustler (L.P.).	Stage 1: LO_2/RP-1. Stage 2: RFNA/UDMH.	78 0	8 0	108,500 (Discoverer)	1,250 lb. in 300 mile orbit	Launching vehicle for Discoverer programme. Thor-Agena B (top stage over 25 ft. long×5 ft. dia., with approx. twice propellent capacity of Agena A) will restart in space.
THOR-DELTA	STL	Stage 1: 1×150,000 lb. s.t. Rocketdyne MB-3 (L.P.). Stage 2: 1×7,700 lb. s.t. Stage 3: 1×3,100 lb. s.t. ABL×248 (S.P.).	Stage 1: LO_2/RP-1. Stage 2: WFNA/UDMH. Stage 3: double-based solid.	92 0	8 0	112,000 (Echo)	480 lb. in 300 mile orbit	Non-polar launchings. Launching vehicle for NASA Echo 100 ft. dia. inflatable satellite.
TITAN	Martin	Stage 1: 2×150,000 lb. s.t. Aerojet-General×LR-87 (L.P.) Stage 2: 1×80,000 lb. s.t. Aerojet-General×LR-91 (L.P.).	Stage 1: LO_2/RP-1. Stage 2: LO_2/RP-1.	— 98 0 (basic)	— 10 0	— 220,000	— 5,000 lb. in 300 mile orbit	Launching vehicle for Dyna-Soar sub-orbital prototypes; possibly other space missions.
VANGUARD	Martin	Stage 1: 1×28,000 lb. s.t. General Electric×405 (L.P.). Stage 2: 1×7,500 lb. s.t. Aerojet-General AJ-10 (L.P.). Stage 3: 1×2,300 lb. s.t. ABL×248 (S.P.).	Stage 1: LO_2/kerosene. Stage 2: WFNA/UDMH. Stage 3: Solid.	72 0	3 9	22,600	25 lb. in 300 mile orbit.	First satellite-launching vehicle developed by U.S.A. Last of series launched Sept. 18, 1959 (Vanguard III).

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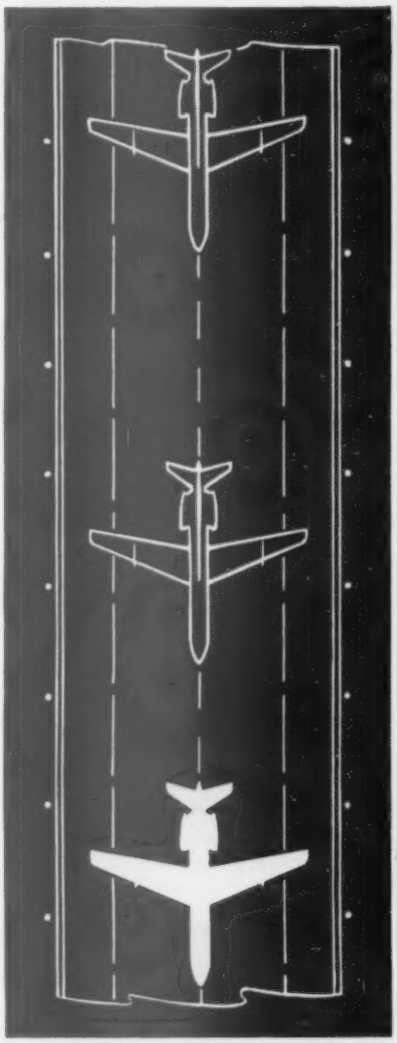
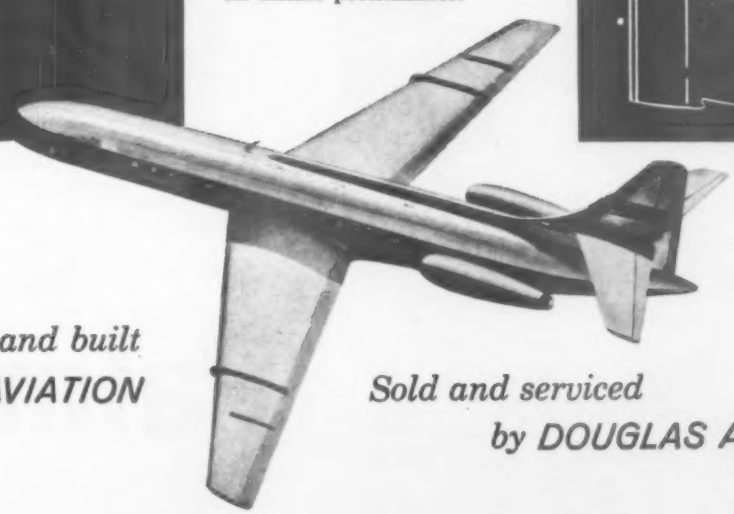


LANDING DISTANCE
3600 FEET



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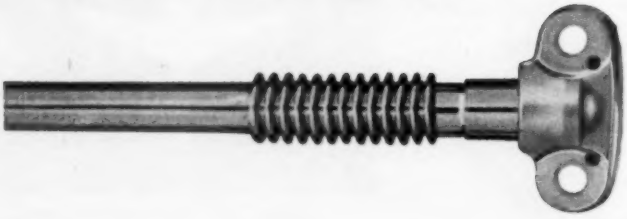

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The Fighting Services

Recent Air Rank Appointments

AIR VICE-MARSHAL P. D. Holder, D.S.O., D.F.C., until recently Air Officer Commanding, R.A.F. Hong Kong, has become Assistant Chief of the Air Staff (Training). In 1953 he was appointed Deputy Director of Policy (Air Staff) at the Air Ministry. Before going to Hong Kong he completed the 1956 Imperial Defence College Course.

Air Cdre. G. H. White, C.B.E., has been appointed Air Officer Commanding, R.A.F. Record Office, Gloucester. Previously Air Commodore in charge of Organization at Headquarters, Maintenance Command, he served in a similar capacity at Headquarters, Technical Training Command, from 1953 to 1956.

Another appointment is that of Air Cdre. A. A. F. Hickman, O.B.E., as Director of Technical Training at the Air Ministry. Until recently, Senior Technical Staff Officer at Headquarters, Middle East Air Force, Air Cdre. Hickman was previously Chief Aircraft Supply Liaison Officer to the Ministry of Supply.

Gp. Capt. W. N. Hibbert, Deputy Director of Financial Services at Headquarters, R.A.F. Germany, has been appointed Director of Personal Services (B) at the Air Ministry, with the acting rank of Air Cdre. From 1953 to 1955 he was Gp. Capt. in charge of Organization at Headquarters, Maintenance Command, and from 1955 until 1958, when he took up his present appointment, he served at the Air Ministry in the department of the Director of Personal Services.

At Headquarters, Signals Command, Gp. Capt. B. H. Boon, O.B.E., has become Controller of Telecommunications with the acting rank of Air Cdre. Appointed Chief Signals Officer at Headquarters, Allied Air Forces Northern Europe, in 1955, he later became Chief Signals Officer of Maintenance Command and recently completed a guided weapons course at the R.A.F. Technical College.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Wg. Cdr. C. E. Castle, M.B.E., to the Department of the Air Member for Supply and Organization.

Fighter Command: Wg. Cdr. E. B. O'H. Bennett to Headquarters, No. 12 Group, as Group Signals Officer.

Coastal Command: Wg. Cdr. T. S. W. Towell, D.F.C., D.F.M., to Headquarters, No. 18 Group, as Senior Officer in charge of Administration.

Transport Command: Sqn. Ldr. L. F. Wolsey, to R.A.F. Colerne to command No. 36 Squadron, with the acting rank of Wg. Cdr.

Flying Training Command: Sqn. Ldr. C. F. Green, A.F.C., to R.A.F. Cranwell to command the Flying Wing, with the acting rank of Wg. Cdr.

Maintenance Command: Gp. Capt. D. N. Corbyn to R.A.F. Heywood to command No. 35 Maintenance Unit.

R.A.F. Germany: Wg. Cdr. K. R. Bowhill, O.B.E., to R.A.F. Geilenkirchen to command the Flying Wing.

Other Appointments: Gp. Capt. P. G. D. Farr, O.B.E., D.F.C., to Air Headquarters, Malta, as Senior Air Staff Officer; Wg. Cdr. W. G. Welch to Melbourne on exchange posting with the R.A.A.F.; Wg. Cdr. H. G. Slade, A.F.C., to Air Headquarters, Malta, for planning duties; Sqn. Ldr. B. S. G. Button to the staff of Air Commander-in-Chief, Eastern Atlantic Area, with the acting rank of Wg. Cdr.

HUNTERS OVER SALISBURY.—No. 8 Squadron recently returned to Aden from a goodwill visit to the Royal Rhodesian Air Force at Thornhill, Southern Rhodesia. Here, four of the Squadron's Hunter FGA.9s are seen over Salisbury.

Australian Helicopter Training

FOUR Australian Army pilots are attending the Royal Australian Navy's first combined Services helicopter course which started at the Naval Air Station at Nowra, New South Wales, last month.

In the past the R.A.N. has provided helicopters for certain Australian Army activities, but this new training programme will make the Army self-sufficient in this respect. All four Army pilots attending the course are already qualified on fixed-wing aircraft and their training will include simulated jungle flying from restricted landing areas.

It was announced recently that the Army was acquiring a helicopter wing for reconnaissance and liaison duties.

More Service News

No. 216 Squadron History.—Flt. Lt. R. A. Locke, of No. 216 Squadron at R.A.F. Lyneham, is anxious to hear from anyone who has photographs of the Squadron's aircraft and of incidents in which they were involved. He is particularly concerned with the unit's operation of Bristol Bombays. The Squadron also wants to know more about the history of its silver.

Escaping Society Trophy.—Flt. Lt. A. E. Warner, a Javelin flight simulator instructor at R.A.F. Geilenkirchen, has won this year's award of the R.A.F. Escaping Society Trophy.

Auxiliary Appointment.—Gp. Capt. K. Gray, R.A.F. (Retd.), has become C.O. of No. 2 (City of Edinburgh) Maritime Headquarters Unit, R.Aux.A.F., with the auxiliary rank of Wg. Cdr.

MIXED MARKS.—Three Javelin FAW.9s of No. 25 Squadron led by a Mark 7. Based at Waterbeach, the Squadron is commanded by Wg. Cdr. J. H. Walton, A.F.C.

Aviation News in General

CZECH CONTEST. — The British team of John Ayers, Peter Phillips, Charles Boddington and Michael Popoff who are participating in the World Aerobatic Contest in Bratislava later this month, are flying out, together with Mr. Norman Jones and an engineer, Mr. Dennis Cheeseman, to Czechoslovakia on Aug. 25. They are taking the Deacon and Archbishop Tiger Moths, plus the Jodel Mousquetaire in support, and are travelling via Lympne, Calais, Gosselies, Frankfurt, Munich, Linz and Schwechat.

TURBOFAN CERTIFICATE.—The Pratt & Whitney JT3D turbofan has been granted its approved type certificate by the F.A.A. Its first commercial use will be in the Boeing 120Bs and 720Bs of American Airlines. Other airlines which have ordered the 17,000 lb.s.t. JT3D are Avianca, Lufthansa and Ethiopian for their 720Bs and United, K.L.M. and Iberia for DC-8s.

ELECTRA MODIFICATIONS.—Lockheed has now concluded agreements with 10 of the 13 airlines using Electras covering their modification to strengthen the wing and engine nacelle structure (see our Jly. 29 issue). The first modified aircraft is expected to fly at the end of September, and will undergo extensive strain gauge testing. A second modified Electra will be available for F.A.A. certification flying by mid-November and the approval target date is Dec. 16.

LE BOURGET, 1961.—Dates of the 24th Paris Aero Show have been announced. The event will be held at Le Bourget from May 26 to Jne. 4, 1961, culminating in major flying displays on the last two days.

ROLLS-ROYCE ENGINES. — The thrust with reheat of the Avon RA.24R has been revealed; it is 14,430 lb. Official mention can also be made of two projected Rolls-Royce engines, the RB.153 and RB.161. It has been reported that the RB.153 is a small high-thrust engine which is the subject of a development agreement between Rolls-Royce and the German M.A.N. Turbomotoren company.

CARAVELLE DELIVERED. — The first east-west crossing of the North Atlantic by a Caravelle was made on Jly. 25, on its delivery flight to General Electric. It is to be fitted with CJ805-23 turbofans as the prototype Caravelle 7. Air France is reported to be seeking Government permission to buy two more Caravelles, for use by Air Liban and Tunis-Air.

NEW RAMJET.—Bristol Siddeley has revealed the existence of a new 18-in.-diameter ramjet, the BSRJ.824. Intended for operation at high altitude and high supersonic speeds, its reliability and performance have been proven on the company's high-altitude test plant. This ramjet, which is 99.6 in. long, may well power advanced versions of the Bloodhound surface-to-air missile.

ARGOSY TOUR.—Before returning to this country at the end of its Indian demonstration tour, the Argosy G-APRN flew to Amman at the invitation of King Hussein of Jordan. This Argosy, which will be seen at Farnborough next month, has flown 85,000 miles and visited 25 countries in the past three months.

WARTIME RELICS.—No. 60 Maintenance Unit at R.A.F. Church Fenton has recently restored to their original condition three wartime German aircraft, for permanent exhibition at various stations. The types comprised a Messerschmitt 410A4/U2 for Cosford, an Me 110G4/R6 for Biggin Hill, and a Fieseler Storch for Finningley.

FUJI FLIES.—The prototype Fuji-built T1B jet trainer has been flying since May 17 with the Nippon Jet Engine Co., J-3 turbojet in place of its original Bristol Orpheus turbojet. The Fuji jet trainer, which was described in our issue of Mar. 6, 1959, is the first major all-Japanese aircraft design to be developed since the War, and is to be produced as an intermediate trainer for the JASDF, to replace the current Harvards. Twenty Orpheus-powered T1As are being built at Utsunomiya, and the J-3 is then to be introduced in production T1B aircraft.

ANOTHER SPRITE.—Royal Navy and Army versions of the Westland Saro P.531 Wasp are to be known as the SeaSprite and Sprite respectively. Both are powered by the Blackburn A129 Nimbus engine. Commercial versions with Nimbus or Gnome will probably retain the name of Wasp. In the U.S., the Kaman HU2K-1 helicopter was also recently named SeaSprite.

JAPANESE JETS.—Training is due to start next year of about 230 pilots and 2,900 ground personnel of the Japanese Air Self-Defence Force for the Lockheed Starfighters to be acquired by Japan. Domestic production is planned of 180 F-104J fighter-bombers, together with 20 F-104DJ trainers.

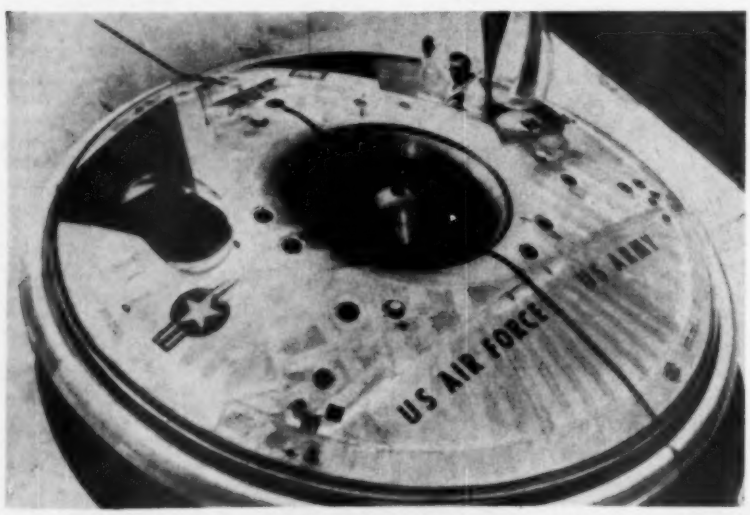
DOUGLAS MISSILEER.—U.S. Navy has selected Douglas to build the Missileer, a subsonic, low-performance launching platform for the Bendix Eagle two-stage solid propellant air-to-air missile. The Missileer will have two 8,500 lb. Pratt & Whitney TF30-P-2 turbofans and weigh 50,000 lb. The development and production programme is expected to extend over 10 years and cost a total of $3,400 million.

EUROPEAN SPACEFLIGHT.—The British Interplanetary Society is to organize a three-day European Symposium on Space Technology in London on Jne. 26-28, 1961. Object is to bring together scientists and engineers from Western Europe to discuss the possibility of formulating a joint programme of aerospace research and development.

CAPSULE SETBACK.—A production MA-1 Mercury capsule of the type designed to carry a man into orbit 120 miles above the Earth next year was destroyed on Jly. 29 when the Atlas booster (Big Joe) apparently exploded some 65 seconds after leaving Cape Canaveral. The capsule, which was heavily instrumented for a sub-orbital test, was expected to ascend 110 miles and reach a re-entry speed of 13,000 m.p.h.

SPACE BUSINESS.—Plans for a global telephone and TV network based on a system of 50 polar-orbiting satellites at altitudes of about 3,000 miles, have been outlined by Bell Telephone Laboratories. System would include 600 telephone channels and a TV service between each pair of 26 ground stations. Estimated cost is $170 million, and overseas companies and/or agencies would be expected to share satellite launching and replacement costs.

ECHO LAUNCH.—An attempt to launch a 100-ft. dia. inflatable sphere for use as a passive reflector in radio communication experiments was expected this week at Cape Canaveral. Planned orbital inclination is about 47° to the Equator, orbital height, 1,000 miles, and period about 120 min. Two tracking beacons transmitting on the same frequency (107.94 or 107.97 M/cs.) were being fitted 180° apart on the equator of the aluminium-coated mylar balloon.



DISC-SHAPED.—The Avrocar developed by Avro Aircraft, Ltd., of Canada for the U.S. Department of Defense employs the ground cushion effect for take-off and landing and is said to be capable of a maximum speed of 300 m.p.h. and a range of 1,000 miles. It has three Marbore turbojets. The Avro "Omega" was discussed at length in THE AEROPLANE for May 1, 1953.

Commercial Aviation Affairs

AIR AFRIQUE.—Last month Air France announced an agreement with Union Aéromaritime de Transport for the co-ordination of trunk services to and within Africa. This agreement has been reached with the approval of Transports Aériens Intercontinentaux, in so far as its long-haul services in the area are concerned. Air France/U.A.T. services will be operated under the name Air Afrique — Société de Transport Aérien en Afrique.

EASTERN 720s.—Ten Boeing 720s have been ordered by Eastern Air Lines for delivery in 1961. Altogether 82 medium-haul 720s and 163 707s have now been ordered and 140 of these had been delivered by the end of July. Eastern's 720s will be powered by P & W JT3C-12s.

E.A.A.C. COMET.—The first of two de Havilland Comet 4s for East African Airways was handed over on Jly. 25 and flown to London Airport by a B.O.A.C. crew. Flying training of six E.A.A.C. captains, five first officers and six engineers began on Jly. 27, the B.O.A.C. Comet Flight providing instructors. The Comets will go into service between Nairobi and London on Sept. 17, and will subsequently serve Dar es Salaam and Johannesburg.

NEW PACIFIC LINK.—Real-Aerovias Brasilia-Nacional is about to open a trans-Pacific service from Sao Paulo, Rio de Janeiro and Brasilia to Tokyo via Bogota, Mexico City, Los Angeles, Honolulu and Wake Island.

QUIETER AT MONTREAL.—Department of Transport rules now effective at Montreal Airport establish minimum-noise traffic patterns for jet aircraft. The rules involve rapid-climb techniques and flight paths avoiding built-up areas.

SKYCOACH PLANS. — The new "third class" services to East Africa, now known as Skycoach flights, will start on Oct. 4 at a fortnightly interval. East African Airways will provide two flights in each sequence of four, with B.O.A.C. and British United Airways providing one each of the others. The first Skycoach to Ndola, Lusaka and Salisbury will operate on Oct. 10 and C.A.A., B.O.A.C. and B.U.A. will take it in turns to provide this fortnightly service. Existing coach-class services to Africa will become economy class from Oct. 1, at a similar standard as at present, and the B.U.A. tourist class service to West Africa will become economy class from Oct. 3.

FRENCH TWIN.—First flown on Jly. 29, the Bastan-powered Super Broussard is a 20-23-seat general-purpose transport jointly developed by Avions Max Holste and Nord Aviation. More details are on page 180.

M.E.A. AND MASCO.—The aircraft engineering work of the Middle East Aircraft Service Co. is now undertaken by Middle East Airlines. All MASCO staff are being offered a transfer to M.E.A. and Mr. W. K. Forsyth, B.O.A.C.'s manager, line maintenance, has become M.E.A.'s engineering controller. MASCO's general manager, Mr. George Carayan, is now M.E.A.'s assistant managing director (engineering).

UNITED ARAB AIRLINES. — The expected merger between Misrair and Syrian Airways, the national airlines of the two United Arab Republic countries, took effect last month. The name United Arab Airlines will be introduced in due course by the new single company, which is reported to be planning extensions of its Comet services to India. An Atlantic service from Cairo via the U.K. is also being planned and suitable aircraft are now being evaluated.

CHEAP CHARTER. — Member airlines of the U.S. Independent Airlines Association have submitted plans to the C.A.B. for North Atlantic charter flights at a fare of $222 (£79 4s.) return. The fare is based on the cost of chartering a Constellation with a full 99-passenger load and would be available for a 14-day period between New York and London, Paris, Amsterdam, Geneva or Frankfurt. The flights would be available only to members of clubs qualifying under C.A.B. rules for charter operations.

SLICK CL-44s.—Reports that Slick might cancel its order for two Canadair CL-44s following the loss of Logair contracts (our issue for Jly. 15) have been denied by both the airline and the aircraft makers. The company describes itself as "definitely committed" to the purchase of these aircraft, which will be used on its common carriage routes.

News About People

ROLLS-ROYCE SALES.—Gp. Capt. S. Wroath, C.B.E., A.F.C., R.A.F. (Retd.), has joined the technical sales department of the Rolls-Royce Aero Engine Division. His responsibilites will be in the field of engines for military aircraft.

707 MANAGER.—Captain T. B. Stoney has relinquished his appointment as manager of B.O.A.C.'s 707 Flight on medical advice, and has returned to line flying. He is succeeded by his former deputy, Capt. T. Nisbett, and the new deputy is Capt. J. Woodman.

NEW A.R.B. MEMBER.—Mr. C. R. Jeffs, underwriter and manager, Aviation and General Insurance Co., has been appointed a member of the Air Registration Board. Ray Jeffs has had a long experience in aviation insurance and originally joined "British Aviation" in January, 1939. He returned to aviation insurance after serving as a pilot in the Fleet Air Arm during the War and was appointed to his present post in January, 1959. He held a commercial pilot's licence for 14 years and is an Upper Freeman of the Guild of Air Pilots and Air Navigators.

Mr. C. R. Jeffs who, as recorded left, has been appointed a member of the Air Registration Board. He is underwriter and manager to the Aviation and General Insurance Co., Ltd.

B.A.C. PUBLICITY. — Mr. Charles Gardner, O.B.E., has been appointed publicity manager of the British Aircraft Corporation, Ltd. He will be responsible for all publicity, advertising, sales publicity material, and public relations for the British Aircraft Corporation and its products. For aircraft matters he will be responsible to Mr. A. H. C. Greenwood, chairman of the Corporation's joint sales committee, and, on guided weapons, to Mr. Eric Beverley, sales manager, guided weapons, of the Corporation. Mr. Robert J. Blackburn succeeds Mr. Gardner as sales publicity manager, Vickers-Armstrongs (Aircraft), Ltd., and Mr. John H. Motum has been appointed deputy sales publicity manager of the company.

B.E.A. APPOINTMENTS. — New appointments at management level announced by B.E.A. are as follows: Mr. Roy Roberts to be manager for Italy; Mr. David Craig to be B.E.A. reservations manager; Mr. Harry Collis to be sales manager, United States; and Mr. Peter Leuw to be B.E.A. sales development manager.

T.W.A. CHIEF QUITS.—Mr. Charles S. Thomas has resigned as president, chief executive officer and a director of T.W.A., on completion of the two-year term for which he was originally appointed.

DAN-AIR DIRECTOR.—Mr. L. E. Moore, general manager of Dan-Air Services, Ltd., has been appointed a director of the company.

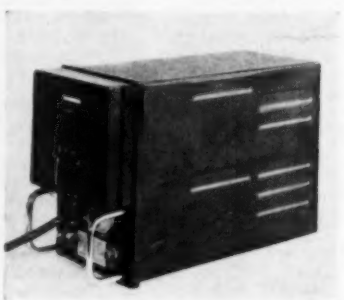
Personal Flying

AFTER an opening fly-past, the Bank Holiday display at Fair Oaks by the Tiger Club continued with aerobatics by Michael Popoff in the "Deacon," while another display later in the show by Peter Phillips in the "Archbishop" afforded an interesting contrast in styles. Four members of the Tiger Club—Michael Popoff, Peter Phillips, John Ayres and Charles Boddington—are competing in the aerobatic championships in Czechoslovakia at the end of this month, taking with them these two much-modified Tiger Moths.

A prominent feature of the programme was a spot-landing competition by the British Parachute Club. Winner of the final was John Hogg, with Bernard Green second.

There was some startling formation flying by four Turbulents led by Clive Francis—very close together, and with several smart formation changes. They followed with a tail chase and an orgy of streamer-cutting, ending with a dive under a tape stretched between two poles in front of the crowd. Two Turbulents both converged on this equivalent of a circus hoop simultaneously, only swerving away at the last minute, as prearranged.

Two Tiger Moths then took off, instructor in one, pupil in the other. "What goes up must come down," said commentator David Ogilvy somewhat ominously, and sure enough the pupil got everything wrong—and eventually, to the crowd's horror, he jumped out. His aeroplane then went into a spin, gyrating down past the "pupil" suspended from his parachute. Dennis Hartas was the pupil, Mike Reilly the parachutist, David Phillips the "instructor."



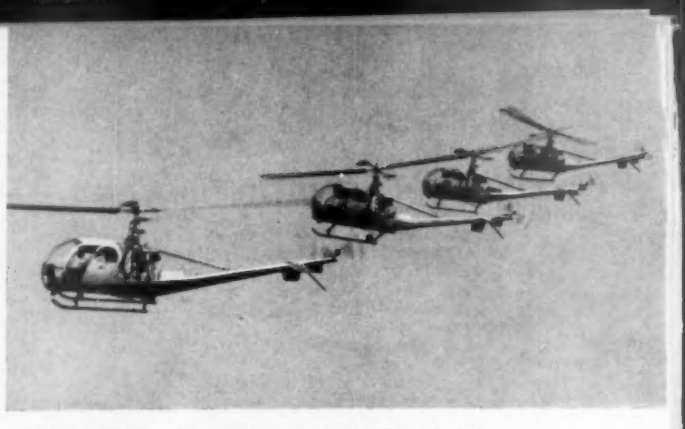
The Burndept five-channel VHF airborne transceiver BE. 255, specially produced for private or business aircraft, will shortly be in production for light aircraft.

The new game of Air Cricket was demonstrated, with Bill Chesson gallantly defending his wicket against a rain of flour bombs.

There was some tied-together formation flying by Lewis Benjamin, C. Nepean Bishop and Clive Elton, and a Turbulent Race round the aerodrome. This, again, was rigged, in the worst tradition of the turf. There were demonstrations of individual aircraft, including the tiny home-built Taylor Monoplane. There was an enormous thunderstorm, which fortunately didn't last long. It was, in all, an excellent Bank Holiday performance. Bill Chesson was general organizer, Sqn. Ldr. John Severne display controller.

BIGGIN DISPERSAL.—In this recent photograph of the Surrey and Kent Flying Club hangar can be seen a variety of club and private aircraft, including Prentices, Tiger Moths, Hawk Trainers, a Chipmunk, and the veteran Klemm L-25-1A.

Photograph copyright "The Aeroplane and Astronautics"



EXECUTIVE E4s.—The new four-seat Hiller UH-12E-4 helicopter was F.A.A.-certificated on Jly. 29, 1960, and delivery is to begin in the near future.

The twin-Astazou Turbo-Travelair, illustrated on Jly. 22, which recently started its flight-test programme in the hands of M. J. Lecarme, is apparently rather more than an engine/airscrew test-bed, and one of these modified Beech aircraft has been ordered by M. J. Szydlowski, the Turbomèca chairman, for his business use. With its extraordinary power margin, the Turbo-Travelair can cruise at more than 300 m.p.h., while carrying five persons, and can take-off and land in less than 200 yd.

• • •

Cessna expansion in the United States has continued with the recent acquisition of the entire capital of the McCauley Industrial Corporation, leading manufacturer of propellers for business and private aircraft. In addition to its expanding commercial sales, Cessna recently received a contract for 35 U-3B light transports, which are military versions of the Model 310D.

• • •

The British Women Pilots' Association were hostesses last week to a party of "99s," who are their equivalents in the United States, and who are visiting Europe. Some 28 American women pilots were entertained at Londonderry House on Aug. 2 by members of the B.W.P.A., the Royal Aero Club and by Lady Casey, patron of the Australian Women Pilots' Association.

Among the visitors were Mrs. Herman Heise, the international president of the "99s," who has over 2,600 hours' private flying, while Mrs. George M. Whyte has some 13,000 hr., plus single- and multi-engined land and seaplane, instructor, instrument, ground engineers, Link trainer and helicopter ratings to her commercial licence. Many others of the guests were equally distinguished, and included Mrs. A. P. Machado of Brazil, who learned to fly in 1921, and is the holder of the oldest active licence of any woman pilot in the World (F.A.I. No. 77, issued on Apr. 9, 1922).

• • •

● At Elstree, the London School of Flying recently introduced its first Auster J1/N Alpha, available at the same rates as the Autocrat, at £4 10s. an hour. Recognizable behind the new Gipsy Major Ic engine is the familiar registration G-AGXT, but in addition to having an unrivalled climb performance, this repowered Auster will have dual brakes, a steerable tailwheel and new electrical intercom.

A tea patrol is being held on Sunday, Aug. 14, when it is hoped that the weather will be kinder than it was for the Elstree Rally on Jly. 10.

Elstree airfield is to have the contractors in for runway resurfacing in late September or early October.

A recent change by the Ministry of Aviation has resulted in the airfield moving out of the London Control Zone, giving unrestricted airspace up to 1,500 ft. The new boundary of the Zone is on a line running east-west about 1½ miles to the south of Elstree.

● At Fair Oaks, the former free lane out of the Control Zone along the railway line from Woking to Guildford has been superseded. The new free lane is from the S.W. corner of the airfield to Brookwood Cemetery, and then either via the Hog's Back or Guildford railway station. The alternative is designed to keep Fair Oaks aircraft away from the Wisley approach lane.

● June was a record month for the Oxford Aeroplane Club, the weather being very good except for one or two days of heat haze and smoke. Michael Eustatiou has gained his P.P.L. on his Tri-Pacer, and another of these aircraft was soloed by Eddie Portman.

Correspondence

U.S.-engined British Aircraft

WITH Farnborough once again at hand, the time seems ripe to repeat the plea for the British aircraft with the American engine.

The arguments against exhibiting such a thing all seem to hinge upon the belief that if it be permitted, we will ultimately have to include the Patagonian prototype incorporating all British split-pins. The possibility of the existing rule being amended to include just what we need seems to present either an insurmountable problem to implement or a grievous ethical affront.

One now hears whispers at the bar that S.B.A.C. will shortly stand for Society of Both Aircraft Constructors; an indication that a little support and extra representation would be appreciated. So might it not be possible to think again and let us see some of the new British aircraft now flying, which might prove a great commercial success at home and abroad if allowed to show their paces from the best shop window.

As a nation we should be justly proud of our engine design achievement. It would seem, therefore, a pity that we allow a small chip to grow upon the shoulder because we have to import some engines in a category we do not attempt to build ourselves.

London, W.1. K. HUMPHREY SHAKEWELL.

The Status of SATCO

WHILST it would be invidious to comment on the claims put forward in your issue of Jly. 22 on behalf of the Netherlands SATCO system, the statement that it is probably a year in advance of other automatic systems under development in the U.S.A. and elsewhere is too much to remain unchallenged. It would be interesting to learn the identity and nationality of the individuals described in your editorial as "those competent to judge."

Whilst joining you in applauding the enterprise of our Netherlands friends, may I point out that there are competing systems also actively seeking endorsement in European countries and elsewhere, which in the opinion of others equally competent to judge are rather more likely on grounds of technical superiority to gain international acceptance.

Ealing, W.5. E. W. PIKE.
General Precision Systems, Ltd.,
Air Traffic Management Division.

As Seen from Holland

FIRST of all we would like to thank you very much for the kind review you gave in your Jly. 22 issue of our SATCO (automatic air traffic control) system on the occasion of its inauguration at Schiphol. In matters of aviation, praise from the United Kingdom is praise indeed, and we are grateful.

In your leading article of the same issue, however, you voice what is naturally to us a somewhat disturbing opinion, namely, that successful electronic developments outside the United Kingdom should not be bought by the British Government. Admittedly, the burden of your argument primarily concerns military equipment, but the extension of this argument to other types of systems for which the Government is also the only customer is a natural corollary.

We believe that this is not a good approach either to encouraging new developments or to promoting trade. In the case of new developments, it is our experience that these tend to be more energetically and more successfully pursued when carried out by private enterprise, at least in their initial stages, rather than by government support.

In the case of SATCO, for instance, we found it well within the normal development resources of our firm to develop and design at least the key components of the system entirely as a private venture. We did, of course, do our best to ensure by detailed consultations with a number of interested administrations that the basic concept and philosophy of the system was approved before committing ourselves to the development cost involved, but it was only after we had made and demonstrated the laboratory model of SATCO that we sought and obtained a Dutch Government contract for the operational equipment. We see no reason why the British electronic industry should not have been able to have done the same sort of thing in the United Kingdom, and obviously we feel strongly that our potential market in the United Kingdom should not be penalized simply because British industry was previously unwilling to match our initiative in this particular field. Nor do we believe that the British Government should be blamed.

At the time we started SATCO, nearly five years ago, there was not a single administration in the Western world, including the United States, that was prepared to do more than scratch the surface of automation as a potential tool for air traffic control—a fact which, of course, also had a bearing on the lack of interest and initiative on the part of industry. We took the risk, however, and we hope that we might now be judged on the merits of what we have to offer without being impeded by chauvinistic tendencies which, we submit, are out of place within the joint community of Great Britain and Europe.

Hengelo, Holland. A. K. MARTIENSSEN. (N.V. Hollandse Signaalapparaten.)

Groundabout

Shuttleworthy Cause. At the Army Air Corps display, Allen Wheeler organized a collection among the crowd to assist the Shuttleworth Trust, whose Bristol Fighter was beautifully flown by "Doc" Stewart. This seems rather a scratchy way of raising funds and leads to the obvious idea of an annual Ancients' Day (A.D. for Anno Domini, of course) at which every available historic aircraft would be shown and, if possible, flown. Like the old R.Ae.S. Garden Party but bigger—and for money, for the glorious old 'uns.

*

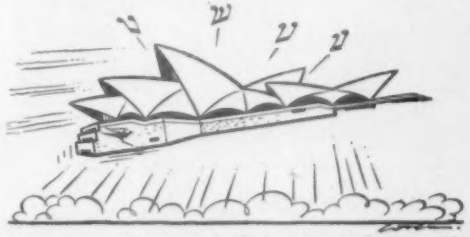
Fings Ain't Wot They Used Ter Be. *Occasion:* B.B.C. TV interview with R.A.F. Corporal Fitter Aero-Engines.

Interviewer: "How would you carry out a minor repair?"

Cpl.: "I would deal with it *in situ*."

*

Beating Time. At the Australian architectural exhibition at the Qantas Galleries in Piccadilly (they also sell airline tickets) the model of Sydney's new opera house suggested to me, even more than the drawings of it had done, a VTOL Mach 3 airliner designed by the Air League. And quite perchance, there were, nearby, copies of the supersonic time-table compiled by Cedric Turner, Qantas chief executive, predicting 2,000 m.p.h. travel in the early '70s, leaving Sydney at 10 a.m. and, with local time differences, arriving London, via the Middle East, at 1.30 p.m. the



same day. I'm surprised he didn't forecast the fantastic trans-Pacific, crossing-the-International-Dateline schedule. Travelling that way, even in a slowcoach of a 707, I left Sydney at 4 p.m. Wednesday and was in London at 8 p.m. Thursday. And the tape-recorded cabin music will be replaced in ten years' time by an actual orchestra, the Sydney Symphony—real Mendellsonic, Bach 3 stuff, sport!

*

Brief. Letter in *The Times* on the correspondence about whether a Channel bridge or tunnel would be best:

"Dear Sir,
Why either?
Yours truly,
Eoin C. Mekie,
Chairman, Silver City Airways, Ltd."

*

From My Favourite Line Book

Hairy Old W.O., settling argument among long-service types about who has got most time in: "Listen, you lot—when God said 'Let there be light!' I was duty electrician."

Lig

Industry Record

A Bristol Film

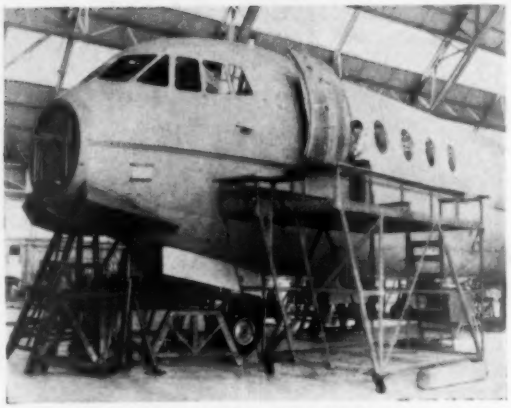
The premiere of the first film produced by the newly-formed Bristol Siddeley film unit was held in London recently. Dealing with the Orpheus turbojet engine, it explains its basic engineering features, describes how it is assembled at Filton, and shows some of the aircraft into which it is fitted.

Some of the air-to-air sequences of the Gnat Trainer in the film are among the best we have seen for a long time. Quite obviously a good deal of thought went into getting the best possible scenic cloudscapes as a background. One particularly effective shot is a take-off, as seen from the rear seat over the pilot's shoulder.

In addition to these shots of the Gnat, the film has some equally fascinating sequences showing Fiat G-91s of the Italian Air Force in action at Treviso (see THE AEROPLANE AND ASTRONAUTICS for Jne. 24). These particular scenes include some remarkable high-speed ultra-low-level passes of the G-91 across the aerodrome. And a few camera-gun shots are included to give some good "what the pilot sees" impressions during air interceptions.

Of particular interest in this excellent little film are some air-to-air sequences of the Lockheed Jetstar and some shots of the Japanese Fuji TIF-2 trainer both being built and in the air. These "imported" sequences, however, are nothing like so good in quality as the home-produced sections by the Bristol Siddeley film unit.

This little Orpheus documentary is in colour and on 16-mm. sound film. It runs for about 16 min. and is available on loan from Bristol Siddeley Engines, Ltd., for showing to *bona fide* audiences. It is well worth getting.—F.T.M.



Access platforms made of Dexion slotted angle are being employed in the construction of the Vickers Vanguard. The same Dexion angle has been used for Viscount production at Weybridge.

A New Aircraft Loader

Dennis Bros., Ltd., of Guildford, have produced a new aircraft loader designed to offer efficient and reliable load handling for the present and future generation of transport aircraft.

Its chassis is a development of a Dennis heavy-duty underfloor-engined design, using a Perkins P.6 power unit. The driver's cab is offset to the right-hand side so that all operations are in full view of the driver; in particular, the accurate positioning of the machine relative to the aircraft.

The loader's low platform body is arranged to lift to a height of 12 ft. and a roller conveyor and bridge facilitate the handling of loads of up to five tons of passenger baggage, freight or servicing equipment. A motor-driven power conveyor may be fitted if required and loading or unloading may be undertaken at the front, rear or right-hand side.

A scissor-type lifting mechanism is used, hydraulically elevated with fully automatic push-button control from alternative stations. At the desired height, hydraulically applied wedge-brakes lock the platform and at the same time the mechanism is electrically and hydraulically interlocked to prevent misuse; in any event the mechanism is designed to "fail safe."

The new Dennis aircraft loader which has a minimum laden platform height of 3 ft. 10 in. Fitted with a roller conveyor system, the platform can be raised to a height of 12 ft.

Air Surveillance Radar

Decca Radar have produced a brochure covering the results of the Royal Swedish Telecommunications Authority trials on the 10-cm. Decca air surveillance radar Type D.A.S.R.1 installed at Arlanda Airport, Stockholm. Using a J-29 for the flight trials, the Authority established that the D.A.S.R.1 coverage on a 10-sq.-metre target at 80% probability of paint is gap free to heights above 40,000 ft. out to a range of approximately 120 miles.

Aviation Calendar

Aug. 14

Elstree Aerodrome.—Tea Patrol, organized by the Elstree Flying Club.

Aug. 15

Stockholm.—11th International Astronautical Congress; until Aug. 20.

Aug. 16

London.—Metal Physics Committee of the Institute of Metals lecture, "The Physical Nature of Plastic Flow," by Dr. J. J. Gilman, at the Institute of Metals Headquarters, 17 Belgrave Square, S.W.1, at 18.30 hrs.

Aug. 17

London.—Kronfeld Club talk on the National Gliding Week, at the Basement, 74 Eccleston Square, S.W.1, at 20.00 hrs.

Aug. 20

London.—Science Museum lecture, "The Story of Flight," by Victor Wall, in the Science Museum, Exhibition Road, S.W.7, at 15.15 hrs.

Aug. 29

London.—European Congress of Aviation Medicine on "Human Problems of Supersonic and Hypersonic Flight," until Sept. 2.

Sept. 1

London.—Society of Instrument Technology and British Interplanetary Society Symposium on "Rocket and Satellite Instrumentation," at Manson House, 26 Portland Place, W.1.

Sept. 5

Farnborough.—S.B.A.C. Air Show; until Sept. 11.

Sept. 8

Varenna, Italy.—AGARD and Lomard Institute of Science and Letters Seminar on "Propulsion for Astronautics;" until Sept. 12.

Company Notices

NEW COMPANY

Ian Maclean (Holdings), Ltd. (664,960).—Private co. Reg. Jly. 13. Cap. £100 in £1 shs. Designers, manufacturers, constructors, and assemblers of and dealers in aeroplanes, gliders, airships, helicopters, etc. Sols.: Hextall Erskine and Co., 135/47 Cheapside, E.C.2.

RECEIVERSHIP

Jackaroo Aircraft, Ltd. (584,052). Thruxton Acrodrome, Andover, Hants. James H. Wilson of Bucklersbury House, Bucklersbury E.C.4, was appointed Receiver on Jne. 20, 1960, under powers contained in debenture dated Mar. 6, 1959.

New Patents

APPLICATIONS ACCEPTED

848,759.—**Vyzkumny A Zkusebni Letecky Ustav.**—"Stabilizing system for rotorcraft."—Feb. 20, 1957.

848,879.—**Aerojet-General Corporation.**—"Steering and manœuvring miniature submarines, airships and other craft."

849,307.—**General Electric Co.**—"Manœuvre limiter for aircraft."—Aug. 29, 1957. (Aug. 31, 1956.)

849,212.—**Power Jets (Research and Development), Ltd.**—"Supersonic aircraft."—Feb. 21, 1957. (Mar. 1, 1956.)

848,623.—**Union Carbide Corporation.**—"High-speed plasma generators."—Feb. 19, 1959. (Feb. 20, 1958.)

849,073.—**Blackburn Group, Ltd.,** formerly **Blackburn and General Aircraft, Ltd.,** and **Clark, F. M.**—"Parachutable assembly for use in dropping loads from aircraft."—Jan. 20, 1959. (Addition to 829,401.)

848,679.—**Boeing Airplane Co.**—"Noise suppressor and thrust reverser for aircraft jet engines."—Oct. 23, 1958. (Apr. 14, 1958.)

Printed specifications of the above will be available on September 12, 1960, and the opposition period will expire on December 12, 1960.

Personal Notices

BIRTHS

Birch.—On Jly. 28, at R.A.F. Hospital, Cosford, to Nina (*née* Griffiths), wife of Flt. Lt. A. Birch—a son.

Steedman.—On Jly. 31, at Louise Margaret Hospital, Aldershot, to Elizabeth (*née* Graham) wife of Sqn. Ldr. W. F. D. Steedman—a son.

Whittaker.—On Jly. 30 at Royal Lancaster Infirmary, to Ann, wife of Flt. Lt. D. Whittaker—a son.

MARRIAGE

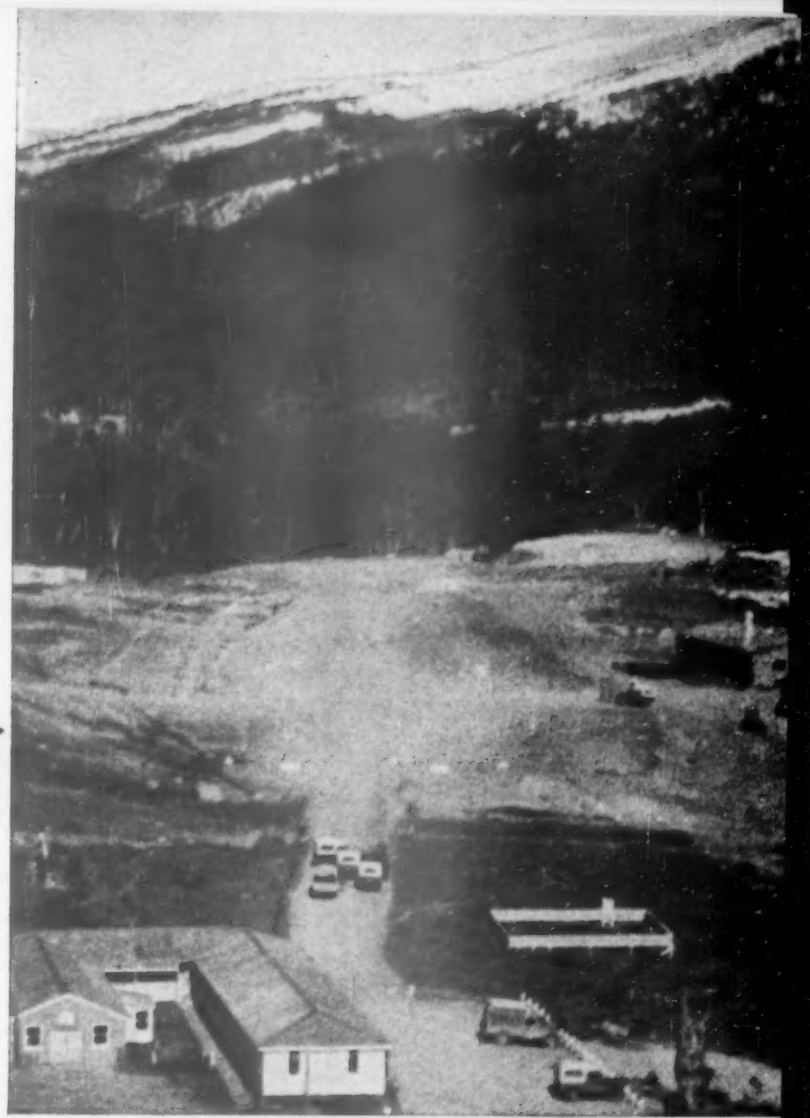
Dymond-Lübbe.—On Jly. 29, at Christ Church, Down Street, London, W.1., Flt. Lt. James Nicholas Dymond to Dorothea Lübbe.

DEATH

Williams.—On Aug. 1, Wg. Cdr. Ronald James Williams, R.A.F. (Retd.).

from strips like this.....

the S.T.O.L.



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The Personnel Manager, HUNTING AIRCRAFT LIMITED, Luton Airport, Beds.

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PRESS DAY: Classified Advertisements must normally be received at Head Office by **FIRST POST THURSDAY** for the following Friday week's issue. Last-minute additions and deletions are accepted by telephone from trade advertisers up to noon. Advertisements received too late for a particular issue are automatically inserted in the succeeding one unless instructions to the contrary are received.

RATES—1/- per word (minimum 12 words 12/-). Each paragraph charged separately and name and address must be paid for. Semi-displayed setting £3-17-6 per single column inch. Centred lines 22/6. Series discounts of 5% for 13, 10% for 26 and 15% for 52 consecutive insertions, allowed to trade advertisers.

TERMS—Strictly net and prepayable. Monthly accounts for settlement by the end of the month following insertion are allowed to trade advertisers if satisfactory references are provided.

REMITTANCES—Cheques and postal orders should be crossed and made payable to TEMPLE PRESS LIMITED and instructions sent addressed to the Manager, "The Aeroplane and Astronautics," Bowling Green Lane, London, E.C.1.

DEPOSIT SYSTEM—Facilities are available to readers to purchase advertised goods through "The Aeroplane and Astronautics." Commission 1½ (minimum 2/-) on amount deposited.

BOX NUMBERS—Private advertisers desiring to have replies sent care of "The Aeroplane and Astronautics," may do so on payment of 1/- to cover booking and postage, plus cost of four extra words. Box Numbers must not be used for the purpose of circularizing and the Proprietors do not undertake the distribution of such matter received. To avoid mistakes in forwarding, Box Numbers should be carefully and legibly copied and replies sent to Box A000, care of "The Aeroplane and Astronautics," Bowling Green Lane, London, E.C.1.

THE PROPRIETORS retain the right to refuse or withdraw advertisements at their discretion and are not responsible for clerical or printers' errors, although every care is taken to avoid mistakes.

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These applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on July 30, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. 547-1

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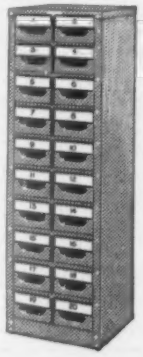

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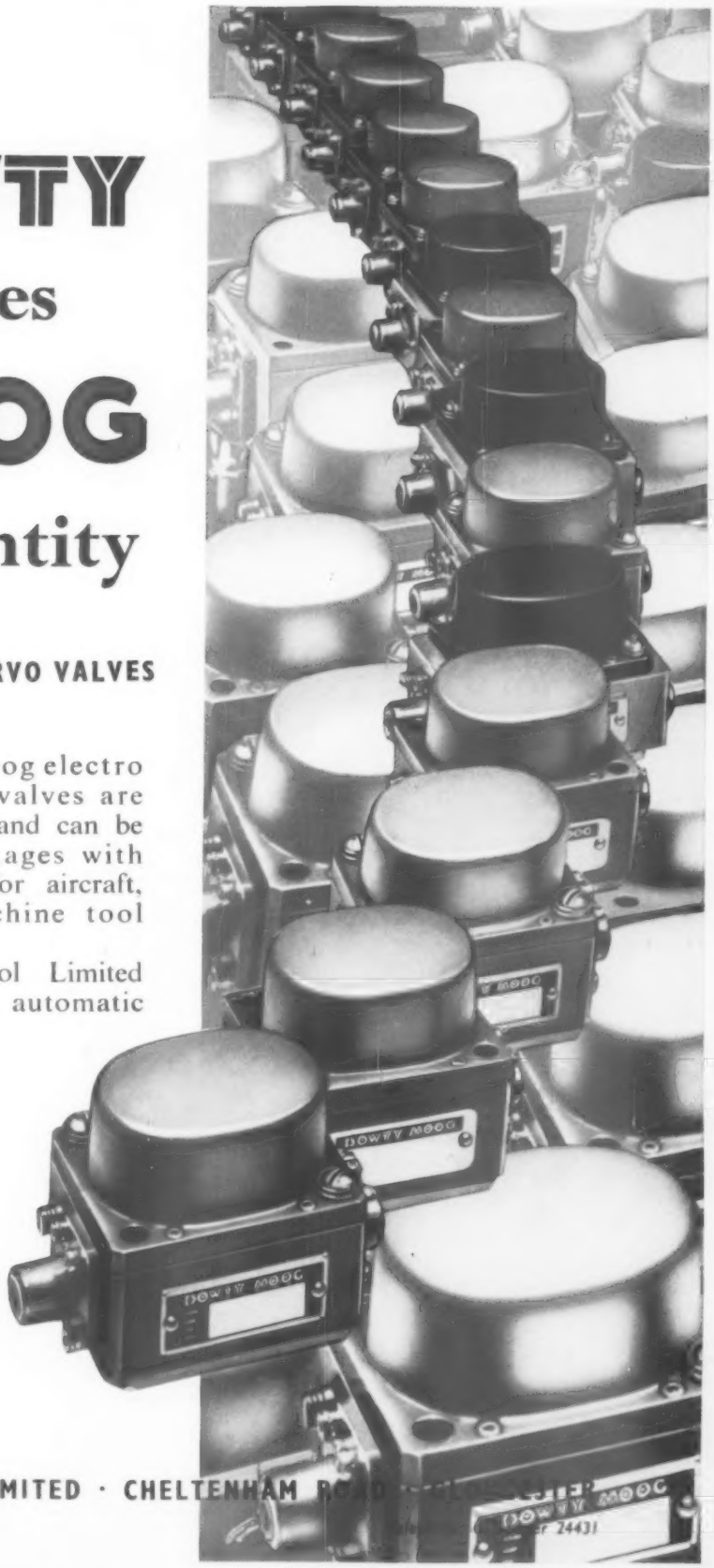

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Such a description might amuse the driver of this Shell tank lorry as he peers through the almost blinding sheet of rain. Nice weather for ducks, perhaps, but not for driving heavily-laden lorries.

But he presses on. His cargo is aviation fuel and his destination is Niamey, a major airport across the Niger in West Africa. Niamey needs supplies in bulk all the year round; yet each delivery means an 800-mile journey from the nearest supply port at Lagos — 800 miles through sub-tropical forest, dense bush and barren plain in all extremes of weather from scorching drought to lashing rain.

The fuel is first shipped by lighter from Lagos 120 miles across the lagoon to Porto Novo. It then travels 300 miles north by rail wagon through jungle swamp to Parakou. From there tank lorries slog out the final gruelling 575 miles to Niamey. Many problems have had to be tackled to get supplies through on schedule. For example, the ancient ferry over the Niger; the treacherous track which, when the rains come, can quickly change from hard corrugated ruts to a sea of mud. At one time the lorries got bogged down frequently and supplies had to be sent by rail to Kano and then by road to Niamey — some 1,200 miles to supply a point only 620 miles from the coast!

But one by one the problems have been overcome and the route improved. Local interests have built 120 miles of bitumen roads (bitumen from Shell). A bridge has now replaced the antiquated ferry over the Niger. Niamey never has, and never will, run short. Wherever an airfield is situated, Shell will supply it — whatever the difficulties may be.

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